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WORKS

OF THE HONOURABLE

ROBERT BOYLE.

VOLUME IV.

Ex rerum Causis Supremam noscere Causam.

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TO
THE RIGHT HONOURABLE
ARTHUR ONSLOW Eſq;
Speaker of the Houſe of Commons,
And one of HIS MAJESTY's Moſt Honourable
PRIVY COUNCIL,

THIS

FOURTH VOLUME

OF THE

WORKS

OF

The Honourable *ROBERT BOYLE*

Is humbly dedicated,

By his moſt devoted and

Moſt obedient Servant,

Andrew Millar.

NEW EXPERIMENTS ABOUT THE SUPERFICIAL FIGURES of FLUIDS, ESPECIALLY OF LIQUORS contiguous to other LIQUORS.

First printed in the *Philoſophical Tranſactions*, N°. cxxxi. p. 775.

SIR,

IN compliance with your curioſity, I herewith ſend you my rude notes about the ſuperficial figures of contiguous liquors, which belonging to a paper (concerning the pores and figures of bodies,) whereof they made the laſt part, and being themſelves very indigeſted, I ſhould by no means venture to expoſe them even to a leſs critical eye than yours, if I did not hope, that, though a more diſcerning reader will ſooner diſcover their imperfections, yet he may be more inclined than an ordinary one would be to think them not uſeleſs trifles; ſince, if theſe trials and hints, as mean as they are, be proſecuted by naturaliſts, that have mathematical heads, perhaps they may conduce more to the phyſical theory of the grand ſyſtem of the world, than at firſt one would ſuſpect. And that I may leave you and your ingenious friends the greater opportunity and freedom to exerciſe their ſagacity on theſe phænomena, I have purpoſely forborn to engage in ſpeculative diſcourſes upon them, contenting myſelf to have faithfully recited matter of fact, and thereby to have ſprung game for thoſe, that have more leiſure and ability to fly at it.

——WHAT has been ſaid about the pores of liquors may be ſomewhat illuſtrated or confirmed, if I ſubjoin to it ſome of the trials I have made about the ſurfaces of fluids contiguous to other fluids. For this being, for ought I know, a neglected ſubject, and the little, that has been taken notice of about it, conſiſting of a few ſlight and caſual obſervations, that ſeem to have been rather preſented to us, not to ſay obtruded upon us, than deſignedly made by us; I many years ago thought, it might be worth while to ſpend ſome hours upon Experiments of this ſort: Which I was eſpecially induced to do, becauſe I think, one may probably enough ſuppoſe, that in the tract of the univerſe, that is yet known to us, there is not the hundredth, perhaps not the thouſandth, part, that is formed into ſolid bodies, ſuch as the earth, the moon, and the other planets; and conſequently all the reſt is made up of celeſtial fluids and the atmoſpheres of ſolid globes, which, for ought we know, though not manifeſtly differing in tranſparency, may be diſterminated by diſtinct ſurfaces. So that, to obſerve and conſider the effects of the congruity and incongruity, that liquors, or ſuch fluid bodies, as directly or otherwiſe fall under ſenſible obſervation, have, when they are contiguous to one another, or to the ſurfaces of ſolid bodies, may not only improve what is yet known about the aſcenſion of liquors in ſmall pipes, but may perchance ſerve to illuſtrate the formation of thoſe great maſſes of matter, of which the divine architect has framed the mundane globes, and ſome other conſiderable parts of the univerſe; eſpecially if we admit the Carteſian hypotheſis, *That the ſun, and all the fixt ſtars are fluid bodies*.

THE cauſe, why water in narrow pipes aſcends above the level of the ſurrounding water, having been already enquired into by ſome ingenious men, and particularly by Mr. *Hooke*, I ſhall not now diſcourſe of that ſubject, nor ſo much as mention what I have tried about it; but ſhall rather take notice that, becauſe I ſuſpected, that the concave figure, which may be obſerved in the ſurface of water included in ſlender pipes, may, at leaſt in great part, depend upon its relation to the contiguous fluid, which, in ordinary caſes, is the air; I thought fit to try, whether this concave figure would not be altered by ſubſtituting another liquor in the room of the air: and accordingly having procured a ſtrongly *Alcalizat Menſtruum* (I uſed that made of fixt niter, diſſolved by the moiſture of a cellar) into a pipe of glaſs, ſealed at one end, and not full a quarter of an inch in bore; that the cavity, which in a greater breadth would ſeem leſs deep, might be the more conſpicuous; we gently poured on it ſome highly dephlegmed ſpirit of wine, which we knew would not mix with it, but ſwim above it; and preſently, as we had gueſſed, we found the figure of the ſurface of the lower liquor changed, and the cavity quite deſtroyed; the ſurface that ſeemed, as it were, common to the two contiguous liquors, appearing flat or horizontal. And ſuch **Exp. i.**

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ſuch a level ſuperficies we had, by putting thoſe two liquors together in a much wider glaſs.

Exp. ii. WE found alſo, that by employing oil of turpentine inſtead of ſpirit of wine, the liquor did almoſt totally loſe its cavity.

Exp. iii. BUT if, inſtead of deliquated tartar, we put common water into the pipe, we found this liquor to retain its concave ſurface, though we put to it ſome oil of turpentine and left it to reſt upon the water a good while.

IN regard that, when oil and water are put together, the oil, that has been employed to produce the phænomena, wont to be afforded by their contact, has uſually been common oil, as that of olives, which is lighter than water; I thought it expedient to try what figures would be afforded by the ſurface of water and alſo by that of air, when thoſe fluids ſhould become contiguous to an oil, heavier than water: of which ſort chymiſtry had afforded me more than one or two beſides the eſſential oils of cloves and cinnamon. Exp. iv. Having therefore provided ſome pure oil of the gum of *Guajacum*, and poured a little of it into a ſlender pipe, we found the upper ſuperficies of it to be concave; almoſt, if not altogether, like that, which water would have had in the ſame pipe. But when I put a little water upon this oil, it preſently changed the figure of its ſurface, which became viſibly, though not very much, protuberant or convex.

AND in regard this oil, though heavier than water, is not ſo heavy as deliquated ſalt Exp. v. of Tartar, I thought fit to try, whether the phænomenon would not be differing upon the contact of thoſe two liquors; and accordingly having put ſome oil of Tartar into the ſlender pipe, and put ſome drops of the oil of Guajacum to it, we found, that this liquor did not manifeſtly alter the concave figure of the ſurface of the liquor Alcali, as the oil of turpentine had done: and having, for curioſity ſake, warily poured a little water upon the oil of Guajacum, I found, as I had reaſon to ſuſpect, that the upper ſuperficies of it changed preſently from a concave figure to a convex, ſo that this oil in the midſt of the other two liquors appeared like a little red cylinder, which, inſtead of having circular baſes, was protuberant at both ends, but more at that which touched the oil of Tartar.

To vary a little the experiment, I put Exp. vi. ſome eſſential oil (as chymiſts call it) of cloves into a new ſlender pipe, and having obſerved it to be ſomewhat concave at the top, where it was contiguous to the air, we cauſed a little common water (perhaps a quarter of a ſpoonful or leſs) to be put to it, and found, as we expected, the ſurface of this oil alſo to become tumid. And in regard this liquor, as well as the forementioned oil of Guajacum, though it were ſo heavy as to ſink in water, would not do ſo in deliquated ſalt of Tartar, we did, into another ſlender pipe, put firſt ſome of this laſt named liquor, then ſome of the aromatic oil, and laſtly a little common water; by which means we found, that the little cylinder of oil did, like that of the oil of Guajacum, appear convex at both ends, but was unlike it in one circumſtance, that the oil of cloves appeared more convex at the upper end, where it was contiguous to the water, than at the lower, that leaned upon the ſurface of the oil of Tartar.

HAVING made theſe trials, to alter, by another contiguous fluid than the air, the concave ſuperficies of water and ſome aqueous liquors, I proceeded to try, whether a change Exp. vii. would not likewiſe be made on the convex figure of the ſurface of quickſilver included in the like ſlender glaſſes; and accordingly, having taken one that was much longer, but of the like bore with the former (for to make the trials more uniform, I had cauſed a long pipe to be by the flame of a lamp unequally divided into ſeveral ſhort ones) we put into it a ſmall quantity of quickſilver; and having taken notice how the upper ſuperficies ſwelled in the middle above the level of the parts, where it touched the glaſs, we poured ſome water upon it, and found a manifeſt and conſiderable depreſſion of the ſurface, though the protuberance were not quite ſuppreſſed.

THIS phænomenon having been for greater ſecurity ſeveral times repeated, I thought fit Exp. viii. to try, what variation would be made, by the greater or leſſer height of the water incumbent on the mercury. And ſometimes it ſeemed, that, when the aqueous cylinder was much longer, the depreſſion of the mercurial ſurface was ſomewhat greater. But this did not ſo conſtantly happen: but we often obſerved, that, though a very little water ſufficed by its contact to make, in the judgment of the eye, a manifeſt abatement of the protuberance of the quickſilver, yet it had not the ſame effect on that ponderous fluid, that it had, when, being increaſed almoſt as high as the length of the pipe would permit, a greater weight of it was incumbent on the mercury. For then I manifeſtly perceived and ſhewed to others, that the ſurface of the quickſilver being depreſſed almoſt to a level in thoſe parts of it, that were near the inſide of the glaſs, there was about the middle of the ſurface an elevation of mercurial matter, that appeared to be rather more than a half globe, and was to the height of its full ſemidiameter, raiſed above the reſt of the mercurial ſurface; and in that ſtate it continued as long as I thought fit to let it do ſo. And leſt this tryal ſhould impoſe upon me, I cauſed it to be more than once repeated; and, the better to confirm it, I afterwards cauſed the incumbent water to be little by little ſuckt up, and found, as I expected, that when the incumbent water began to be too much ſhortened, the little teat or ſegment of ſphere, lately mentioned, began to be ſomewhat flattened, and ſubſided more and more as the water was further taken off.

Exp. ix. BECAUSE the common atmoſpherical air we breath is a fluid body abounding with groſſer particles, and is by divers philoſophers probably ſuppoſed to be much more denſe and heavy than the æthereal ſubſtance, that makes the other part of the atmoſphere; I thought fit to try for their ſakes, whether or no the ſuperficial figure of liquors would be altered by having the contiguous air withdrawn from about them, and ſo being left to be touched by the purer æther without it; and accordingly having conveyed into one of our pneumatical receivers a couple of ſuch ſlender pipes as have been already deſcribed, one of them furniſhed with common water, and the other with quickſilver, we cauſed the common air to be diligently pumped out, without obſerving any ſenſible change in the concave figure of the water: but as for the quickſilver, I knew not what to conclude about it. For having repeated the trial twice or thrice, the mercury ſometimes ſeemed manifeſtly to ſwell to be more protuberant upon the exhauſtion of the receiver, than when it was put in, eſpecially when its figure was attentively viewed, and the external air, that was pumpt out but ſlowly, was ſuffered to re-enter with all convenient celerity. But that which yet kept me doubtful was, that I obſerved, that upon the diligent withdrawing of the air's preſſure on the quickſilver, there diſcloſed themſelves in it ſome little bubbles, which I feared we had not been able to free it altogether from, and which might be ſuſpected to have ſome intereſt in the phænomenon; which though it was at that time hindered by ſome occaſions from proſecuting further, yet I think it may be well worth the while, becauſe, if any ſenſible change do certainly appear to be made in the ſuperficial figure of the mercury, it may teach us ſomewhat relating to the conſtitution of the æther, which ſeems to make up far the greater part of the univerſe known to us; and I ſhould not in that caſe think it impoſſible, that by expoſing many and differing liquors to its contact *in vacuo Boyliano* (as it is called) ſome diſcovery may be made of differing ſubſtances, whereof one may ſuſpect the æther itſelf not to be uncapable. But to leave ſuſpicions, that probably will be thought chimerical, I ſhall only add, which I forgot before, that we conveyed into our receiver a clear chymical oil that was heavier than water, and whilſt it was contiguous to it, had not a concave but a convex ſurface; and having placed the pipe furniſhed with both liquors in the pneumatical receiver, we pumpt out the air without finding that the oil ſenſibly altered its protuberant ſurface, as neither did the water loſe the concave figure of its upper ſurface.

WHEN clouds are condenſed into rain, and lower aggregates of vapors into dew, it is ſuppoſed to be obvious, that the drops of thoſe meteors do, in their paſſage through the air, (which to them is a heterogeneous fluid) acquire a round figure; and when we ſhake oil into water, the portions of the former fluid, during the little time they remain diſtinct (for they quickly reunite into maſſes) are found to be globular. But theſe phænomena are too few and too tranſient to afford any conſiderable obſervation of the figures of fluid bodies, eſpecially if they be quieſcent, and every way encompaſſed by other fluids. Wherefore I thought fit to try what I could do with chymical liquors unapt for mingling, to produce phænomena, that may laſt long enough to allow us to obſerve them attentively, and in ſome caſes to vary them.

Exp. x. FOR this purpoſe, I firſt took fixt niter, (or, which is analogous to it, ſalt of Tartar) reſolved *per deliquium* into a tranſparent liquor; and having filled a clear vial half full with this, I poured on it a convenient quantity of vinous ſpirit exactly rectified, that there might be no phlegm to occaſion an union between the two liquors, which ought, as ours did, to retain diſtinct ſurfaces, and ſpeedily regain them though the glaſs were well ſhaken. Then having found by a trial formerly mentioned, that common oil of turpentine, if employed in a competent quantity, will not totally (and much leſs will readily) diſſolve in ſpirit of wine, and alſo having obſerved (what may ſeem ſomewhat ſtrange) that if this ſpirit of wine be exquiſitely dephlegmed, the oil, though a chymical one, will not ſwim on it, but ſink in it; I warily let fall ſome drops of the oil into the ſpirit, and had the pleaſure to ſee, as I expected, that they fell towards the bottom of the glaſs, till their deſcent was ſtopt by the horizontal (for it was not concave) ſurface of the Alcalizat liquor of fixt niter. And becauſe my deſign was chiefly to obſerve the ſuperficial figure of a fluid encompaſſed by other fluids without touching any ſolid body, I ſhall here take notice of the chief phænomena, that were produced of that kind, without ſtaying to enquire into the cauſes or the conſequences of them.

1. IF the oily drops were but ſmall, they ſeemed to the eye exactly enough ſpherical. For the oil differing but very little in ſpecific gravity from the ſpirit of wine, the drops did but juſt touch the ſurface of the ſubjacent Alcali; and the ſame drops being but ſmall, their own weight was not great enough viſibly to depreſs them, and hinder that roundneſs, which the preſſure of the ambient ſpirit, or their own viſcoſity endeavoured to give them.

2. IF an aggregate of drops were conſiderably bigger than thoſe newly mentioned, as if it had about a third part of an inch in diameter, it would then manifeſtly lean upon the Alcalizat liquor as upon a floor, and appear ſomewhat elliptical, (for ſome little part of the bottom was a plain;) the weight of the upper parts depreſſing the drops, and making the horizontal diameter ſomewhat longer than the tranſverſe.

3. IF a yet greater portion of oil were let fall upon the heavy liquor, it would for a pretty while appear in the form of a ſomewhat imperfect hemiſphere, or ſome other

large ſection of a ſphere, the lower part being cut off, (as if a globe were divided by a plain) by the horizontal ſurface of the deliquated ſalt.

4. But if the quantity of oil were not too great, it was pretty to obſerve, that, though at firſt putting in, it did perhaps ſpread itſelf over the ſubjacent liquor, and lie as it were flat upon it; yet by little and little, (for it was but ſlowly) it would by the action of the ambient, concurring with its own tenacity, be crowded together into a figure of a leſſer ſurface, and conſequently leſs hindering the motions of the vinous liquor. For by the action of this ſpirit, the oil would by degrees be raiſed above the ſurface of the fluid niter, and be reduced to the figure, either of half a globe, or of a greater ſegment of a globe, or even of an imperfect ellipſis, according as the bulk or weight of the oil made it more or leſs apt to reſiſt the action of the ambient ſpirit, to whoſe effect, as I lately intimated, the natural viſcoſity of the oil might (more or leſs) cooperate, as alſo might the weight of the ſpirit of wine, which in great part diſabled the endeavour of the oil's gravity to make its figure leſs convex.

5. Though theſe globules or portions of oil did oftentimes readily mingle, when they touched one another, yet divers times alſo we obſerved, that having warily approached them, we were able (as if ſome odd ſubtile matter, that the eye could not diſcern, interpoſed, to keep them unconfounded,) to make them touch without mingling: inſomuch, that we have with pleaſure made them ſo far bear againſt one anothers ſurfaces, as manifeſtly to preſs them inwards, though being parted they would preſently reſume their former figure: which circumſtance ſuggeſted to me ſuſpicions, that I cannot now ſtay to name. But in caſe any of theſe oily portions came by a more preſſing contact to be united, they would then alter the figures they had whilſt ſeparate, and take another, ſuitable to the bulk of the aggregate.

6. When a large portion of oil reſted upon the ſaline liquors, if then the ambient ſpirit were moderately and warily agitated, it was not unpleaſant to obſerve the various figurations, which the convex and protuberant part of the mutilated globe would be put into by theſe ſhakes, without any viſible ſolution of continuity, or conſiderable motion of the whole body, which would very quickly recover its former figure. Though, if the agitation were too ſtrong, ſome portions would be quite broken off, and preſently turned into little globes.

Exp. xi. I tried to produce another phænomenon, that would not have been unpleaſant, by putting together in a ſomewhat large veſſel, with other liquors, two oils, (whereof one, if I miſtake not, was from turpentine,) which firſt, by reaſon of the oleaginous nature, wherein they agreed, might exactly mingle and make a compounded liquor; and then, by reaſon of their being one heavier, and the other lighter *in ſpecie* than water, might by this liquor be again ſeparated, and include betwixt them the liquor, that had divided them. But I found, that the oils being once united would not be eaſily parted, but, according to the prevalency of the lighter or heavier ingredient, in the mixture, the compounded oil, would almoſt totally either emerge to the top of the water, or lie beneath the bottom of it; I ſay, almoſt totally, becauſe ſome parts of the oil, which was not perhaps all uniformly mixt, did not keep in a body with the reſt; but either was ſeparated from the maſs in the form of globules, or elſe, ſticking to the ſide of the glaſs, had the other part of its ſuperficies, which was contiguous to the water, very variouſly figured, according as the bulk and degree of gravity of the adhering oil and other circumſtances happened to determine. And it is chiefly upon the account of this various and odd figuration of our mixture, that I here make mention of this trial; which though it proved not ſucceſsful to me, yet perhaps may ſucceed in the hands of another, that ſhall make it with more leiſure and diligence, than I could afford it.

These are ſome of the phænomena I obſerved in oil of turpentine, when it was invironed only with fluids; but, if it were permitted to be contiguous to the inſide of the glaſs, and ſo to faſten part of its ſurface to a ſolid, the greater part of the ſurface, which remained expoſed to one or both of the contiguous liquors, would, partly by their action, and partly by the gravity of the oil itſelf, be put into figures ſo various, and ſometimes ſo extravagant, that it was much more pleaſant to behold them, than it would be eaſy to deſcribe them; which therefore I ſhall not here attempt to do.

Exp. xii. Whereas I intimated in the preamble to theſe notes, that confining fluids may have diſtinct ſurfaces, without having, at leaſt in many poſitions, refractions differing enough, or reflections ſtrong enough, to make the plain, that diſterminates them, obvious to the eye; I ſhall here obſerve, that when the oil of Tartar, or nitrous Alcali, that I employed, happened to be very clear and colourleſs, I have more than once made highly rectified ſpirit of wine float upon it ſo, that in moſt poſitions the vial ſeemed to have in it but one uniform liquor; the plain, that divided the two fluids, being unapt to be diſcerned, but in a poſition, wherein the rays of light paſſing thence to the eye fell very obliquely on it; and indeed, when there was no little duſt or other feculency ſwimming upon the ſurface of the oil of Tartar, I had ſometimes much ado to convince ordinary ſpectators, that the vial, in two diſtinct regions of it, contained two unſociable liquors.

Exp. xiii. On this occaſion, I ſhall add an experiment, which, though it does not ſo directly belong to our ſubject, as to make its omiſſion a fault, is not yet perhaps ſo impertinent as to be unwelcome.

WE took a deliquated Alcali, made of niter and tartar, and deeply tinged with cochineel; and, that the liquors might not only be heterogeneous, but as differing in gravity and denſity as we could make them, we poured on it a peculiar kind of oil lighter than ſpirit of wine, and holding the plain where the two liquors were contiguous in a convenient poſition, in reſpect of the light and the eye, I obſerved it to make a ſtrangely vivid reflection of the incident beams of light: ſo that this phyſical ſurface, which was flat, looked almoſt, for it was not ſo ſpecular, like that of quickſilver; and when I kept it till night, and conſidered it by the light of a candle, the bright figure of the flame was ſtrongly reflected almoſt as from a cloſe ſpecular body; which tempted me to ſuſpect, that there might be ſomething elſe than the bare ſmoothneſs of the ſurface of the Alcalizat liquor to produce ſo briſk a reflection; and the rather, becauſe I did not obſerve, that the remains of the ſame tinged Alcali, which I kept in another glaſs, nor a portion of the ſame oil, which I had alſo by me in a ſeparate vial, did either of them afford ſo vivid a reflection from its ſurface; though I did the leſs wonder at this, becauſe of the great diſpoſition to reflect light, which I had formerly the curioſity to obſerve in the forementioned oil, when I joined it with other liquors. But, whether this ſtrongly reflecting power, taken notice of in our late recited experiment, proceeded from ſome mixture, as it were, or confuſion of ſingly unperceived particles in the phyſical ſuperficies or plain, where the two liquors confine; or, whether ſome ſuch *materia ſubtilis*, or æthereal fluid, as *Carteſius* and ſome of the antients maintained, inſinuated itſelf between our two liquors, and made the diſterminating ſurface more ſpecular; or whether the phænomenon be rather due to ſome other cauſe, I ſhall not now ſtay to make inquiry. But to help towards it, I ſhall add on this occaſion, that looking on this liquor, as a body, which, though it have all the neceſſary qualities of an oil, does, in regard of its origin, and ſome properties I have found in it, differ from common chymical oils; I was invited the more to obſerve its phænomena in reference to reflection; and I found, among other things, (not pertinent to this place,) *Firſt*, that the confining plain, often mentioned between the tinged Alcali and this liquor, did not appear red itſelf, nor communicate that colour to the image of the flame of a candle reflected from it. *Secondly*, that when I warily ſhook the vial, which contained the two liquors, the uppermoſt would be reduced into a ſeeming froth, conſiſting of a great number of imperfectly globular bodies, which after a while would make a kind of a rude phyſical plain; which, though neither very horizontal nor ſenſibly ſmooth, would, at its upper ſuperficies, ſend back the incident light with more briſkneſs than one would expect. And when the ſeeming froth conſiſted of ſmaller particles, theſe, when they were of a certain ſize, and conveniently placed, in reference to the flame of a candle and the eye, would, (as more than one trial informed me,) reflect the incident light ſo many ways, and ſo viſibly, that they ſeemed, for multitude and ſplendor, like little ſparkling corpuſcles of poliſhed ſilver; or almoſt like thoſe gliſtering ones, that appear, when a clean plate of copper is firſt immerſed into a much allayed ſolution of good ſilver, made in *aqua fortis*.

AND to theſe phænomena I ſhall add a third, which is, that, though pure ſpirit of wine be ſo thin a liquor, and our oil is nevertheleſs ſo light as to ſwim upon it; yet I found the confining ſurface very ſtrongly reflexive. But of this liquor more perhaps may be ſaid in another place.

AND it may, in the mean while, not be impertinent here to intimate to you, that I found, that ſome other eſſential oils (as chymiſts call thoſe, that are diſtilled with water in limbecks) and particularly an unſophiſticated oil of limons, did, with our tinged Alcali, afford moſt of the ſame phænomena; but not ſo briſk a reflection: I ſay, moſt, chiefly becauſe with ſpirit of wine theſe ſubtile oils, as I formerly noted, will readily be confounded; though our anomalous oil be unſociable with it.

A CONTINUATION OF THE EXPERIMENTS

Publiſhed in the

Next foregoing TRACT, about FLUIDS, contiguous to other FLUIDS.

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IN the winter time, and at other times alſo when the air is cold enough, the figure, acquired by the ſurface of an oil contiguous to the water on one ſide, and the air on the other, may be preſerved from varying, and ſo may be at leiſure obſerved by the direction afforded by the following experiment, which I deviſed for this purpoſe.

Exp. xiv. IN cold weather we took eſſential oil of anniſeeds, whoſe property it is to coagulate in ſuch weather; and having in a gentle warmth brought it to be fluid, we poured it into a ſlender vial more than half filled with common water, that had been alſo a little warmed, that the oil might not be too haſtily reduced to its former ſtate. This oil being lighter than ſo much water, and being poured on in a convenient quantity, had its upper ſurface ſomewhat concave, as that of the water was; but the lower ſurface, ſurrounded by the water, was very convex, appearing almoſt (for it was not perfectly) of the figure of a great portion of a ſphere. This being done, the vial was ſtopt, and ſuffered to reſt for ſome time in a cold place, by which means the water continuing fluid as before, the oil of anniſeeds was, as I expected, found coagulated in a form approaching to that it had whilſt in a fluid ſtate; I ſay, approaching, becauſe it was not eaſy to diſcern the exact figure in the vial I was fain to make uſe of: and I ſuſpected, that the oil grown conſiſtent was become leſs convex than before; but the two ſurfaces of it gave it ſome reſemblance in point of ſhape, but not of tranſparency, to a concavo convex glaſs; but yet much thicker in the middle, than is uſual in glaſſes of the like breadth, employed for dioptrical purpoſes. And indeed (to give here this advertiſement once for all) I would not have you underſtand in too ſtrict a ſenſe what my intended brevity, and ſome other motives, make me deliver in naming the figures of fluids. For I confeſs, that if I were to write for a rigid geometrician, eſpecially if he were nice and critical in the doctrine of conic ſections, I ſhould think myſelf obliged on ſome occaſions to a greater curioſity in naming the figures of fluids, than you will meet with in this paper. But ſince I write but notes, and deſign to give you rather experimental hints, than geometrical determinations; I preſume, that when you are once cautioned by a plain advertiſement, it may ſuffice for me to refer the fluids, I deſcribe, to ſuch of the more known figures as they ſeem to be the leaſt remote from, without troubling you or myſelf with maimed figures, or with ſpheroids, conoids, paraboloids, and other hard words; which I the rather abſtain from, not only becauſe the particulars, wherein my fluids reſembled them and differed from them, could not be intelligibly declared without many words; but becauſe I obſerved the figures themſelves of the fluids to vary, and ſometimes conſiderably too, according to contingent circumſtances. And for this reaſon alſo I will not perſwade you to expect, that the event of every trial, you ſhall make of theſe experiments, will be preciſely the ſame with the event of mine. For by reaſon of thoſe contingent circumſtances, I dare only ſpeak hiſtorically of theſe experiments; and, without pretending that they ſhall always uniformly ſucceed, content my ſelf to relate *bona fide*, what trials have been made, and what happened to me thereupon, not deſpairing, that this variation itſelf of events according to circumſtances may be inſtructive.

BUT to return to our lately mentioned oil of anniſeeds, it was worth obſerving, how great a difference there was between the dull reflection it made when it was coagulated, and the fine reflection it had made whilſt it was a liquor. The latter of which reflections brought into my mind, how vivid the reflective power of ſome fluids is in compariſon of that of the generality of ſolid bodies, of which there is ſcarce any, if there be any at all, that is obſerved to have a ſtronger reflection than clean quickſilver; Exp. xv. and yet (to add that upon the by) I have ſometimes found, that this itſelf may be increaſed by the addition of a liquor. For having obſerved, as I elſewhere note, that quickſilver, and rectified *Oleum Petræ* are, the former of them the heavieſt, and the latter the lighteſt of all the viſible fluids, that are yet known to us, or at leaſt to me; and having alſo obſerved the latter of them to be conſiderably reflective, I had the curioſity to try among other things, that related to them, the following experiment. Some (diſtilled) quickſilver being put into a ſmall vial, and held in ſuch a poſture, that the incident light was ſtrongly remitted to my eye, I ſlowly put to it ſome petroleum, that being well rectified was very clear; and obſerved, that, as this liquor covered the quickſilver, there was at the imaginary plain, where they both confined, a briſker reflection than the quickſilver alone had given before. Whether this increaſe of reflective power proceeded from any thing produced upon the confines of the two bodies, or from ſome ethereal fluid that ſlipped in there, I have above declined, and ſhall now forbear, to examine; but on this occaſion it will not be amiſs to take notice, that either the ſurface of the air itſelf, as thin and yielding a fluid as it is, or the ſurface of a ſolid, contiguous to included air, or ſome interpoſed ſubtile matter, may reflect the incident beams of light more ſtrongly than moſt men would expect. To this purpoſe I remember, that a curious perſon having one day brought me a couple of rarities, which he told me were two pieces of a ſolid, but tranſparent, body, that he had caſually found, in one of which there was a pearl, large, round, and orient, and in the other a leſs perfect one; and having deſired my opinion, whether they were conſiderable enough to be preſented to the king; I, after I had ſufficiently viewed them in differing poſitions, and eſpecially againſt the light, aſked him, whether he were ſure the included bodies were pearls. To which when he anſwered, that his eyes permitted him not to doubt of it, eſpecially becauſe he knew of no other gems nor ſtones, that had ſo ſtrong and fine a reflection; I replied, that I thought they might be only bubbles of air, caſually intercepted in the viſcous matter of the containing bodies (which I ſuppoſed, upon good grounds, to have been once ſomewhat fluid) before it came to be hard; adding, that his majeſty, who was critical in theſe matters, might probably have the curioſity, I had, to have the worſt of them broken, to be ſatiſfied what kind of bodies the included were. Hereupon, to content me, one of them was opened; and that which had appeared a pearl was found to be but a cavity, that contained no groſſer ſubſtance than air. And I have by me a well ſhaped piece of glaſs of a good thickneſs, with an aereal bubble in the middle, which by ſome qualities, particularly its pear-like ſhape and vivid reflection, not ill reſemble a fair, though not orient, pearl. But in ſuch like obſervations, the poſition of the eye, and that wherein the body receives the beams of light, may be very conſiderable. For I have by me a ſmall ſtone (with which I have puzzled the ſkilful jeweler of a great prince to determine what kind of gem it is) that being laid flat upon ones hand, or a piece of paper, and looked on directly downwards, looks almoſt like a piece of common glaſs, and is tranſparent: but if the eye be ſo placed, that the incident beams of light, by whoſe reflection it is ſeen, fall with a convenient degree of obliquity upon the ſtone, it makes an exceeding pretty ſhew, ſometimes appearing like a fine opal, and ſometimes not very unlike an orient pearl.

Exp. xvi.

It may not be altogether impertinent, and at leaſt, for the novelty of the way of trial, it will not probably be unpleaſing, if I here mention an attempt to try, whether, when the rays of light rebound from bubbles invironed with an uniform ſolid body (which caſe is ſomewhat differing from that of bubbles looked upon in an exhauſted receiver) the reflection be only, or almoſt only, from the groſſer particles of the air, and not alſo from ſome ſubtile matter harboured, as well as they, in the ſame cavities? But to bring this queſtion to trial ſeemed difficult enough, becauſe it is ſo, to include very rarified air in a conſiſtent body, diaphanous enough to let its reflection be eaſily obſerved. To compaſs this, I thought upon the following expedient. We made, according to the eaſy direction * elſewhere given (for other purpoſes) a competent quantity of a reſinous or gummous ſubſtance, that looked like high coloured amber, but was eaſy to melt. This we put into a deep round glaſs with a wide mouth, and held it by the fire-ſide in a moderate warmth, till it was brought into a fluid ſtate; then we transferred it into one of our pneumatical receivers, where we preſumed, that this temporary liquor would, as well as liquors that are conſtantly ſuch, diſcloſe aereal bubbles, when the preſſure of the air was withdrawn from it; and accordingly having cauſed the air to be pumpt out by degrees, we found, that ſtore of bubbles appeared at the top of the liquor, and made there a copious froth, many of them being, by reaſon of the viſcoſity of the fluid, very large; and divers of them, becauſe of the nature and texture of it and the thinneſs of the films, being adorned with the colours of the rainbow, whoſe vividneſs made them pleaſant to behold, and ſuggeſted to us ſome optical conſiderations. But notwithſtanding this froth, I cauſed the pumping to be continued, that thoſe bubbles, that had moſt of common air in them, and which therefore are wont to riſe firſt, might get to the top, and the ſubſequent bubbles might meet with more reſiſtance from the liquor ſtill tending to grow cold, and ſo might be the more expanded, and yet kept from emerging by the concretion of the reſinous ſubſtance; and anſwerably to this we found, that, when this ſubſtance had reſumed its conſiſtent form, there were intercepted, between the upper and the lower ſurfaces of it, ſome bubbles, that were not ſmall, which yet had a conſiderable reflection, notwithſtanding the ſmall quantity of the groſſer particles of the air, that may be ſuppoſed to be contained in bubbles ſo very much expanded (perhaps ſo, as to exceed ſome hundreds of times their former dimenſions.) I might add, that by letting the outward air into the receiver, the air in divers

of

* *In the uſefulneſs of experimental philoſophy.*

of the formerly mentioned large bubbles, at the top of the glaſs, was too much rarified to keep them from being broken by the preſſure of the returning air. But I am ſenſible, that, in what I have ſaid of the reflective power of the air, I have already too far digreſſed, and therefore I ſhall ſtep into the way again, and proceed to other obſervations.

Exp. xvii. Water being ſo conſiderable a body here below, I thought, it would be worth while, to endeavour to obſerve its ſurface, when contiguous to other fluids than air, and, if it were poſſible, when ſurrounded by them. For though it is taken for granted, that the falling drops of rain are ſpherical, yet their deſcent is ſo ſwift, both by reaſon of their gravity in reſpect of the air, and the height from whence they fall, that I fear men have rather ſuppoſed than obſerved that their figure is ſpherical; which will be the more queſtionable, if it be true, which is vulgarly thought, that hail is but rain frozen in its paſſage through the air. For it is evident, that the grains of hail are frequently of other figures than truly orbicular. But becauſe there may another poſſible account be given of this irregular figuration of hail, I ſhall not inſiſt on this phænomenon, but proceed to what I tried about the ſurface of water; of which I found it the more difficult to make obſervations, becauſe that liquor will readily mingle both with ſpirit of wine and with oil of tartar, and with other liquors, that are analagous to either of theſe.

Exp. xviii. The ſurface of water may have differing figures, according as it is totally incompaſſed with heterogeneous fluids, or, as it is only in ſome places contiguous to one or more of them. In the former caſe we found it not ſo eaſy to make an obſervation, both becauſe, that, as I lately noted, we know not of any two liquors (ſetting mercury aſide) that will not mingle either with one another, or with water. And becauſe alſo our oil of guajacum itſelf, though heavier than water, would not be ſerviceable on this occaſion, in regard of its being of ſo deep a red, that the figure of the water incloſed in it could not be diſcerned through it; wherefore I made uſe of chymical oil of cloves, as being ſomewhat, and but a little, heavier in ſpecie than water, ſo that ſome drops or ſmaller portions of this laſt named liquor would be almoſt quite invironed with the other: we cautiouſly therefore conveyed into ſome oil of cloves, whoſe ſurface the veſſel permitted to be large enough, ſome portions of common water of differing bigneſſes, taking care, as far as we could, that they might not touch one another; by which means the oil being tranſparent, and yet ſomewhat coloured, it was eaſy to obſerve, that the ſmaller portions of water were ſo near totally invironed with the oil, that they were reduced into almoſt perfect globes; thoſe portions, that were ſomewhat bigger (as about twice the bigneſs of a pea) would be of a figure ſomewhat approaching to that of an ellipſis (for it was not the ſame) and thoſe portions, that were yet ſomewhat larger, though they ſeemed to be ſunk almoſt totally beneath the oil, yet they held to it by a ſmall portion of themſelves, whoſe ſurface was eaſily enough diſtinguiſhable from that of the oil. Theſe large portions of immerſed water, being almoſt wholly invironed with the other liquor, were by it reduced into a round figure, which was ordinarily ſomewhat elliptical, but more depreſſed in the middle than that figure requires. But all this is to be underſtood of thoſe portions of water, that touched only the oil and the air; for thoſe, that touched one another without mingling, and much more thoſe that adhered more or leſs to the ſides of the glaſs, had their ſurfaces too differingly and irregularly figured to be here attempted to be deſcribed.

Exp. xix. As for the ſuperficial figure of water, contiguous, both above and beneath, to other fluids, and laterally to ſome ſolid body, it is not ſo eaſy to be ſure, which of the contiguous liquors is of moſt force to determine the figuration of their common ſuperficies or commiſſure. But however I ſhall relate, that, having into a ſlender pipe of that ſort that has been deſcribed before, put a little oil of cloves, and upon this ſome oil of turpentine, that ſo the water might both above and beneath be touched by heterogeneous liquors, I obſerved not the oil of cloves to be very manifeſtly tumid at the top, nor the lower ſurface of the oil of turpentine (for the upper was concave) to be very convex; for ſomewhat convex it was, downwards. And from this it will be eaſy to conclude the figure of the cylindrical portion of water intercepted between theſe two oils.

That agent or force, whatever it be, that keeps liquors fluid, does likewiſe, whilſt they are ſo, keep their ſurfaces exceeding ſmooth, when they are contiguous to the air and other fluids. But becauſe I thought it doubtful, whether even thoſe liquors, that are (as men uſually ſpeak) naturally fluid, I mean, ſuch as are not made ſo by fuſion, produced in them by the action of the fire, would retain ſmooth ſurfaces, when they have loſt their fluidity, and have their parts no longer inflected and agitated, ſo as to enable them, by the help of gravity, viſcoſity, or both, to levigate (if I may ſo ſpeak) or poliſh each others ſurfaces, as it may be gueſſed in their fluid ſtate they did; I thought it not amiſs, in order to the clearing of the doubt, to make ſome trials with contiguous liquors, whereof one would continue fluid when the other had loſt its fluidity.

Exp. xx. I took then oil of anniſeeds, thawed by a gentle warmth, and common water, and having put them together in a conveniently ſhaped glaſs, they were ſuffered to ſtand in a cold place till the oil was coagulated; which done, it was parted from the water, and by the roughneſs of its ſuperficies manifeſted, as I expected, that, when its parts were no longer agitated and kept eaſily diſplaceable by the ſubtile permeating matter, or whatever other agent or cauſe it were, to which it owed its fluidity, then the contiguous water grew unable to inflect, or otherwiſe place them after the manner requiſite to conſtitute a ſmooth ſurface. And what happened to that part of the oil's ſurface, that was touched by the water, happened alſo to that, which was contiguous to the air; ſave that the aſperity of the laſt named ſurface was differing from the other, which, whether it were an accidental or conſtant phœnomenon, further trial muſt determine. But I have often obſerved, that the upper ſurface of oil of anniſeeds, when this liquor comes to be coagulated by the cold air, was far enough from being ſmooth, being variouſly aſperated by many flaky particles, ſome of which lay with with their broad, and others with their edged, parts upwards.

An inequality and ruggedneſs of ſuperficies I have alſo obſerved in water, when, having covered it with chymical oil of Juniper, and **Exp. xxi.** expoſed it in very cold weather, though the oil continued fluid, yet the water, being frozen, had no longer a ſmooth ſuperficies, as whilſt in its liquid ſtate it was contiguous to the oil. And the like inequality, or rather a greater, we obſerved in the ſurface of water frozen, which had chymical oil of turpentine ſwimming over it; yet a no leſs, if not a much greater, roughneſs may be oftentimes obſerved in the ſurfaces of divers liquors that abound with water, when thoſe liquors being frozen, their ſurfaces have an immediate contact with the air. This I, among others, (elſewhere) obſerved; and I ſhall here add, that having purpoſely cauſed a ſtrong and blood-red decoction of the ſoot of wood to be expoſed in a large glaſs in a very cold night, I was more pleaſed than ſurprized, to find in the morning a cake of ice, that was curiouſly figured, being full of large flakes ſhaped almoſt like the broad blades of daggers, but neatly fringed at the edges. But that which I chiefly mention theſe figures for, is, that they ſeem to be as it were imboſt, being both to the eye and the touch raiſed above the horizontal plain or level of the other ice.

And here I muſt not omit to take notice, that whereas in the recited experiments the rugged ſurface was produced at the confines **Exp. xxii.** of two heterogeneous and unſociable liquors, I have ſometimes obſerved the like phænomenon in one and the ſame liquor; and particularly, not long ſince looking in froſty weather on a vial, where I had long kept oil of vitriol, I perceived, that the cold had reduced far the greateſt part of the Menſtruum into a conſiſtent maſs, whoſe upper ſurface was very rugged and oddly figured, though it lay covered all over with a pretty deal of high coloured liquor, that was not frozen or coagulated, nor ſeemed diſpoſed to be ſo, at leaſt in that degree of cold.

This brings into my mind, that not only bodies, which in their natural ſtate (as it is wont to be called) are fluid; but alſo ſuch, **Exp. xxiii.** as, by the violence of the fire, are made to flow, may be conformable to ſome naturally fluid bodies in their ſuperficial figures. This may be obſerved in the beſt ſort of what the chymiſts call *Regulus Martis ſtellatus*, where the figure of a ſtar, or a figure ſomewhat like that of the decoction of ſoot lately mentioned, will frequently appear imboſt upon the upper ſuperficies of the Regulus; and ſuch a raiſed figure I think I can yet ſhew you, on a maſs of Regulus made of Antimony without Mars. But if, to thoſe two bodies, copper be alſo ſkilfully added, the ſuperficies will be oftentimes adorned with new figures according to circumſtances; though the moſt uſual I took notice of was that of a net, that ſeemed to cover the ſurface of the compounded Regulus. But this is not ſo conſtant, but that I have by me a maſs of a conical figure, conſiſting of two very contiguous, but eaſily ſeparable, parts, whereof the lowermoſt, which abounds more in metal, hath its upper ſurface covered with round protuberances, in ſhape and bigneſs not unlike to ſmall peaſe cut in two; and theſe are ſo really imboſt and elevated above the reſt of the ſuperficies, that the other part of the cone, which is of a more ſcorious nature, has, in its lower ſurface, which exactly fits the upper of the Regulus, cavities, for number, ſhape, and bigneſs, anſwering to the protuberances lately mentioned; which argues, that the Regulus cooled firſt with that inequality of ſurface we have deſcribed, and that the lighter and more recrementitious ſubſtance, continuing longer fluid, had thereby opportunity to accommodate itſelf to the ſuperficial figure of the Regulus, on which it firſt leaned, and was afterwards coagulated.

A SHORT
MEMORIAL
OF SOME
OBSERVATIONS
MADE UPON
An ARTIFICIAL SUBSTANCE, that ſhines without any precedent illuſtration.

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ON Saturday the fifteenth of this month I was after ſupper viſited by Mr. *Kraft*, a famous German chymiſt, who was pleaſed to come and ſhew me a ſtrange rarity he hath newly brought into *England*, to the ſight whereof he allowed me to invite ſeveral members of the Royal Society, he being deſirous, becauſe the matter he employs is very coſtly and of difficult preparation, to be a good huſband of it, and by ſhewing it to ſeveral curious perſons at once, to exempt himſelf from the need of ſhewing it often. The company being met, the artiſt took out of a pretty large box he had brought with him divers glaſs veſſels, and laid them in order on the table. The largeſt of them was a ſphere of glaſs, which I gueſſed to be four or five inches in diameter, being hollow and intire, ſave that in one place there was a little hole, at that time ſtopt with ſealing wax, whereat to pour in the liquor, which ſeemed to me to be about two ſpoonfuls or ſomewhat more, and to look like muddy water made a little reddiſh with brick-duſt or ſome other powder of that colour: he alſo took out of his box three or four little pipes of glaſs ſealed, or otherwiſe ſtopt at both ends, being each of them ſomewhat bigger than a ſwan's quill, and about five or ſix inches long, and having at one end a ſmall fragment or two of that matter, that was to ſhine in the dark.

He likewiſe laid upon the table three or four vials of ſeveral ſizes, but none of them judged capable to hold above very few ounces of water: in each of which vials there was ſome liquor or other, that was neither tranſparent nor well coloured, which liquors I confeſs upon his making no particular mention of what they were to do, I was not curious to compare together, either as to quantity or as to colour. Beſides all theſe ſubſtances, which were fluid, he had in a ſmall cryſtalline button bottle a little lump of matter, of which he ſeemed to make much more account than of all the liquors, and which he took out for a few moments to let us look upon it; whereby I ſaw, that it was a conſiſtent body, that appeared of a whitiſh colour, and ſeemed not to exceed a couple of ordinary peaſe, or the kernel of a hazel nut in bigneſs. Some other things it is poſſible Mr. *Kraft* took out of his box, but neither I or (for ought I know) others of the company took notice of them, partly becauſe of his haſte, and partly becauſe the confuſed curioſity of many ſpectators in a narrow compaſs kept me from being able to obſerve things as particularly and deliberately as I would gladly have done, and as the occaſion deſerved. Which advertiſement may, I fear, be but too applicable to a great part of the following narrative.

The forementioned glaſſes being laid in order upon the table, the windows were cloſed with wooden-ſhuts, and the candles were removed into another room by that we were in: being left in the dark we were entertained with the enſuing phænomena.

I. Though I noted above, that the hollow ſphere of glaſs had in it but about two ſpoonfuls (or three at moſt) of matter, yet the whole ſphere was illuminated by it, ſo that it ſeemed to be not unlike a cannon bullet taken red hot out of the fire, except that the light of our ſphere looked ſomewhat more pale and faint. But when I took the liberty to hold this glaſs in my hand, and ſhake it a little, the contained liquor appeared to ſhine more vividly, and ſometimes as it were to flaſh.

II. I took one of the little pipes of glaſs formerly mentioned into my hand, and obſerved, that though the ſhining matter had been lodged but at one end, yet the whole glaſs was enlightened, ſo that it appeared a luminous cylinder, whoſe light yet I did not judge to be always uniform, nor did it laſt like that, which was included in the vials.

III. In the largeſt of the vials next the ſpherical already mentioned, the liquor that lay in the bottom being ſhaken, I obſerved a kind of ſmoke to aſcend, and almoſt to fill the cavity of the vial; and near the ſame time there manifeſtly appeared as it were a flaſh of lightning, that was conſiderably diffuſed, and pleaſingly ſurprized me.

IV. After this I took up that ſmall cryſtaline vial, that I lately called (by a name familiar in our glaſs-ſhops) a button-bottle, wherein was contained the dry ſubſtance, which the artiſt chiefly valued, as that, which had continued luminous about theſe two years; and having held that vial long in my hand, in the ſame poſition in reference to my eye, and looked attentively at it, I had the opportunity to obſerve (what I think none of the company did) that not only this ſtuff did, in proportion to its bulk, ſhine more vividly than the fluid ſubſtances, but that (which was the phænomen I chiefly attended) though I could perceive no ſmoke or fumes aſcend from the luminous matter, yet I could plainly perceive by a new and briſker light, that appeared from time to time in a certain place near the top of the glaſs, that there muſt be ſome kind of flaſhy motion in the matter that lay at the bottom, which was the cauſe of theſe little coruſcations, if I may ſo call them.

V. The artiſt having taken a very little of his conſiſtent matter, and broken it into parts ſo minute, that I judged the fragments to be between twenty and thirty, he ſcattered them without any order about the carpet, where it was very delightful to ſee how vividly they ſhined; and that which made the ſpectacle more taking, eſpecially to me, was this, that not only in the darkneſs, that invironed them, they ſeemed like fixt ſtars of the ſixth or leaſt magnitude, but twinkled alſo like them, diſcovering ſuch a ſcintillation as that whereby we diſtinguiſh the fixt ſtars from moſt of the planets. And theſe twinkling ſparks without doing any harm (that we took notice of) to the Turky carpet they lay on, continued to ſhine for a good while, ſome of them remaining yet vivid enough, till the candles being brought in again made them diſappear.

VI. Mr. *Kraft* alſo calling for a ſheet of paper, and taking ſome of his ſtuff upon the tip of his finger, writ in large characters two or three words, whereof one being *DOMINI*, was made up of capital letters, which being large enough to reach from one ſide of the page to the other, and being (at leaſt as I gueſſed) invigorated by the free contact of the external air, ſhone ſo briſkly, and looked ſo oddly, that the ſight was extreamly pleaſing, having in it a mixture of ſtrangeneſs, beauty, and frightfulneſs, wherein yet the laſt of thoſe qualities was far from being predominant. And this phænomenon did in more ſenſes than one afford us the moſt of light, ſince not only the characters ſhone very vividly upon the white paper, but approaching it to my eyes and noſtrils, I could diſcern, that there aſcended from them a fume, and could ſmell that fume to be ſtrong enough, and (as it ſeemed to me) to participate of the odour of ſulphur and of that of onions. And before I paſt from the mention of theſe reſplendent characters, I muſt not forget, that either by their light, or that of the globe, or both by the one and the other a man might diſcern thoſe of his fingers, that were neareſt the ſhining ſtuff, and that this being held to the face though without touching it, ſome of the conſpicuouſeſt parts, eſpecially the noſe, were diſcoverable.

VII. After we had ſeen with pleaſure, and not without ſome wonder, the foregoing particulars, the artiſt deſired me to give him my hand, which when I had done, he rubbed partly upon the back of it, and partly on my cuff, ſome of his luminous matter, which as if it had been aſſiſted by the warmth of my hand ſhone very vividly, and though I took not notice of any thing upon my ſkin, that was either unctuous or rough, yet I oftentimes tried in vain by rubbing it with my other hand to take it off, or manifeſtly diminiſh its ſplendor, and when I divers times blowed upon ſome of the ſmaller parts of it, though they ſeemed at the inſtant that my breath beat upon it, to be blown out, yet the tenacious parts were not really extinguiſhed, but preſently after recovered their former ſplendor. And all this while this light, that was ſo permanent, was yet ſo mild and innocent, that in that part of my hand, where it was largely enough ſpread, I felt no ſenſible heat produced by it.

By that time theſe things were done it was grown late, which made Mr. *Kraft*, who had a great way to go home, take leave of the company, after he had received our deſerved thanks for the new and inſtructive phænomena, wherewith he had ſo delightfully entertained us.

Because Mr. *Kraft* had twice attempted to fire heated gun-powder with his phoſphorus, but without ſucceſs; probably becauſe the powder was not very good (as by ſome circumſtances I conjectured) and becauſe it was not ſufficiently heated, before the matter that ſhould ſet it on fire was put upon it, he promiſed me he would come another time to repair that unſucceſsfulneſs: and accordingly, on the two and twentieth of September in the afternoon I received a viſit from Mr. *Kraft*, who told me, he came to make good his promiſe of letting me ſee, that his ſhining matter was able to kindle heated gunpowder; and becauſe no ſtrangers were preſent, I had the fairer opportunity to view it, which I was able to do better by day-light, than I had done by its own light; for when he had taken it with a new pen out of the liquor, with which he kept it covered to preſerve it, I perceived it to be ſomewhat leſs than the nail of one of my fingers, and not much thicker than a ſhilling; and I obſerved, that when it had lain a little while upon a piece of clean paper, and diſcharged itſelf from its ſuperfluous moiſture, it began to emit whitiſh fumes, which ſeemed to be very ponderous, ſince for the moſt part they did not aſcend but ſurrounding the matter, whence they iſſued, by their ſtagnation made as it were a little pond or ſmall atmoſphere about it; ſo that leſt it ſhould waſt too faſt, he was obliged, as ſoon as he had cut off a little corner leſs than half a pins head, to put the ſtuff nimbly back into the vial, out of which he had taken it; where I obſerved it for a very ſhort time to ſend up exhalations into the liquor that covered it, and quickly after, as it were, quenched it. This done the artiſt divided the little corner he had cut off into two parts, one of which he ſpread as far as it would reach upon a piece of white paper, which he preſently after held at a diſtance over a chafing-diſh of burning coals, by whoſe heat being excited, it preſently flaſhed and burnt away; and I having perceived, that there was another part of the paper, which though not heeded by him, had been lightly beſmeared by the ſame matter, I held it over the coals, but at a conſiderable diſtance from them, and yet this little matter nimbly took fire and burnt a hole in the paper. And to ſatisfy myſelf, that the heat did but excite the luminous matter, and that it was this its ſelf that lighted the paper, I held the reſt of the ſame piece of paper far nearer the fire, and kept it there a pretty while without finding it at all ſcorched or diſcoloured. Laſtly, the other part of the divided fragment of the hitherto mentioned matter, Mr. *Kraft* put upon the tip of a quil, and having at a diſtance from the fire, very well dried and warmed ſome gun-powder upon another piece of paper, he laid that paper upon the ground, and then holding his quill upon it, as if it had been a match, within half a minute (by my gueſs) that powder took fire and blew up.

IT will not perhaps be impertinent to add, that on occaſion of the operation I obſerved the air to have on the ſhining ſubſtance when freely expoſed to it, I took a riſe to tell Mr. *Kraft*, that I preſumed it might be worth while to try, whether his phoſphorus did ſhine by virtue of a kind of real or (if I may ſo call it) living flame, which like almoſt all other flames required the preſence and concourſe of the air to maintain it; or whether it were of ſuch a kind of nature, as the phoſphorus of the learned *Baldwinus*, which I ſuſpected to ſhine not like a flame or a truly kindled ſubſtance; but like a red hot iron, or an ignited piece of glaſs, wherein the ſhining parts are not repaired by fuel, as in other burning bodies, but are put by the action of the fire into ſo vehement an agitation, as whilſt it laſts ſuffices to make the body appear luminous. This conjecture Mr. *Kraft* ſeemed much to approve of, when I told him, that the way I propoſed to examine his *noctiluca* by, was to put a little of it into our pneumatic engine, and pump out the air, whoſe abſence, if it were of the nature of other flames, would probably extinguiſh, or very much impair its light; but yet ſince he offered not to have the trial made, probably becauſe he had but very little of his ſhining ſubſtance left, I thought it not civil to preſs him. But to countenance what I ſaid of the nature of Baldwinus's Phoſphorus, I ſhall recite an experiment, that I purpoſely made, to examine whether the preſence of the air were neceſſary to the ſhining of this phoſphorus, as I had long ſince found it to that of ſome pieces of ſhining wood.

WE expoſed for a competent time to the beams of a vigorous light a portion of matter of about the breadth of the palm of ones hand, which we had prepared to be made luminous by them. And then cauſing the candles to be removed (for we choſe to make trial by night) we nimbly conveyed the matter into a receiver, that was kept in readineſs for it, preſuming (as the event ſhewed we might) that by uſing diligence the light would laſt as long as the experiment would need to do: making haſt therefore to pump out the air, we heedfully watched, whether the withdrawing of it would, contrary to my conjecture, notably diminiſh the light of the ſhining matter. And after we had thus withdrawn the air gradually, we tried, whether by letting it return haſtily it would produce a more ſenſible change in the matter (which had been purpoſely put in without any thing to cover it, that it might be the more expoſed to the air's action.) But neither upon the gradual receſs of the air, nor yet upon its ruſhing in, when it was permitted to return, could we certainly obſerve any manifeſt alteration in the luminouſneſs of the phoſphorus, other than that ſlow decrement, that might well be imputed to the time, during which the experiment was making. It being well known, that this luminous ſubſtance requires no long time to make it decay, and by degrees to loſe all its light; ſo that though once there ſeemed to one or two of the byſtanders, upon the return of the air, to be ſome recovery of part of the loſt ſplendor, yet after repeated experiments it was concluded, that the preſence of the air was not at all neceſſary to the ſhining of our matter; and it was judged moſt probable, that the abſence or preſence of the air, had no manifeſt operation on it. I might add to this, that perhaps the preſence of the air is rather hurtful than advantageous to this ſort of lights, ſince for having had a large phoſphorus, that was much eſteemed, and, whilſt I kept it, exactly protected from the air did very well; a part of the glaſs that covered it, having by miſchance been ſomewhat cracked, though none of the ſplinters appeared diſplaced, yet it ſeems ſome of the corpuſcles of the air made a ſhift to inſinuate themſelves at theſe chinks (as narrow as they were) and in not many days made the matter ceaſe to be capable of being made luminous as before. I cannot ſtay to enquire, whether this unfitneſs or indiſpoſition may be imputed to the bare moiſture of the air, or to ſome other ſubſtance or quality, that alone, or in conjunction with the moiſture, may ſpoil that peculiar texture, or conſtitution, that fits the matter of the phoſphorus, aſſiſted by the impreſſions of external light, to become luminous. This, I ſay, I cannot ſtay to examine, though, that this phoſphorus is of a nice and tender conſtitution, and eaſily alterable, I was induced to think, by finding, that the want of circumſtances, ſeemingly ſlight enough, would keep it from being made; and I gueſs, that a convention of circumſtances did more contribute to the production, than any peculiar and incommunicable nature of the matter: becauſe having had the curioſity to make ſome trial upon ſo obvious a material as quick lime, though the ſucceſs did not anſwer my deſigns, yet, neither was it ſo bad, but that ſome luminous quality was produced in the lime by the action of the fire, and a ſaline liquor; and I ſcarce queſtion, but other materials will be found capable of being made luminous by the ſame or the like operation, that is employed by Baldwinus, when that learned man ſhall think fit to communicate his way to the public. But to return to what I was ſaying, that the contact of the air might be rather hurtful than advantageous to the phoſphorus; I ſhall only add here, as matter of fact (for my conjectures about light belong to my yet unpoliſhed notes, of the origin of qualities) that whereas the contact of the air, though it were not free, did in a few days deſtroy the luminouſneſs of a good phoſphorus, yet having included another in a receiver, whence we afterwards pumpt out the air, this matter, though inferior to the other in vividneſs, was ſo little ſpoiled by lying open in our vacuum, that at the end of not only ſome weeks, but ſome months, I found, that the beams of a candle paſſing to it through the receiver, would notwithſtanding the vacuum it yet continues in, ſuffice to re-excite in it a manifeſt light.

AN HISTORICAL ACCOUNT OF A DEGRADATION OF GOLD, Made by an ANTI-ELIXIR: A ſtrange Chemical Narrative.

The PUBLISHER to the READER.

HAVING been allowed the liberty of peruſing the following paper at my own lodging, I found myſelf ſtrongly tempted, by the ſtrangeneſs of the things mentioned in it, to venture to releaſe it: the knowledge I had of the author's inclination to gratify the virtuoſi, forbidding me to deſpair of his pardon, if the ſame diſpoſition prevailed with me, to make the curious partakers with me of ſo ſurpriſing a piece of philoſophical news. And, though it ſufficiently appeared, that the inſuing conference was but a continuation of a larger diſcourſe; yet conſidering, that this part conſiſts chiefly, not to ſay only, of a narrative, which (if I may ſo ſpeak) ſtands upon its own legs, without any need of depending upon any thing that was delivered before, I thought it was no great venture, nor incongruity, to let it come abroad by itſelf. And, I the leſs ſcrupled to make this publication, becauſe I found, that the honourable Mr. *Boyle* confeſſes himſelf to be fully ſatisfied of the truth of ſo much of the matter of fact, as delivers the phenomena of the trial: the truth whereof was further confirmed to me, by the teſtimony, and particular account, which that moſt learned and experienced phyſician, who was aſſiſtant to *Pyrophilus* in making the experiment, and with whom I have the honour to be acquainted (being now in *London*) gave me with his own mouth, of all the circumſtances of the trial. And, where the truth of this ſhall be once granted, there is little cauſe to doubt, that the novelty of the thing will ſufficiently indear the relation; eſpecially to thoſe, who are ſtudious of the higher arcana in the Hermetic philoſophy. For moſt of the phenomena here mentioned will probably ſeem wholly new, not only to vulgar chemiſts, but alſo to the greater part of the more knowing ſpagyriſts, and natural philoſophers themſelves; none of the orthodox authors, as far as I can remember, having taken notice of ſuch an anti-elixir. And, though *Pyrophilus*'s ſcrupuloſity (which makes him very unwilling to ſpeak the utmoſt of a thing) allows it to be a deterioration into an imperfect metal only: yet, to tell the truth, I think it was more imbaſed than ſo; for the part left of it (and kept for ſome further diſcoveries) which I once got a ſight of, looked more like a mineral or marchaſite, than like any imperfect metal; and therefore this degradation is not the ſame, but much greater than that, which *Lullius* doth intimate in ſome places. Theſe conſiderations make me preſume it will eaſily be granted, that the effects of his anti-philoſopher's ſtone, as I think it may not unfitly be called, will not only ſeem very ſtrange to Hermetic, as well as other philoſophers, but may prove very inſtructive to ſpeculative wits; eſpecially if *Pyrophilus* ſhall pleaſe to acquaint them with that more odd phænomenon, which he mentions darkly in the cloſe of his diſcourſe.

An Hiſtorical Account of the Degradation of Gold.

AFTER the whole company had, as it were by common conſent, continued ſilent for ſome time, which others ſpent in reflections upon the preceding conference, and *Pyrophylus* in conſideration of what he was about to deliver; this virtuoſo at length ſtood up, and addreſſing himſelf to the reſt: "I hope, gentlemen, ſays he, that what has been already diſcourſed, has inclined, if not perſuaded you to think, that the exaltation, or change of other metals into gold, is not a thing abſolutely impoſſible; and, though I confeſs, I cannot remove all your doubts and objections, or my own, by being able to affirm to you, that I have with my own hands made a projection, (as chymiſts are wont to call the ſudden tranſmutation made by a ſmall quantity of their admirable elixir) yet I can confirm much of what hath been argued for the poſſibility of ſuch a ſudden change of a metalline body, by a way, which, I preſume, will ſurprize you: for, to make it more credible, that other metals are capable of being graduated, or exalted into gold, by way of projection, I will relate to you, that by the like way gold has been degraded, or imbaſed."

THE novelty of this preamble having much ſurpriſed the auditory, at length *Simplicius*, with a diſdainful ſmile, told *Pyrophilus*: "That the company would have much thanked him, if he could have aſſured them, that he had ſeen another metal exalted into gold; but that to find a way of ſpoiling gold, was not only an uſeleſs diſcovery, but a prejudicial practice."

Pyrophilus was going to make ſome return to this animadverſion, when he was prevented by *Ariſtander*, who, turning himſelf to *Simplicius*, told him, with a countenance and tone, that argued ſome diſpleaſure: "If *Pyrophilus* had been diſcourſing to a company of goldſmiths, or merchants, your ſevere reflection, upon what he ſaid, would have been proper; but, you might well have forborn it, if you had conſidered, as I ſuppoſe he did, that he was ſpeaking to an aſſembly of philoſophers and virtuoſi, who are wont to eſtimate experiments, not as they inrich mens purſes, but their brains; and think knowledge, eſpecially of uncommon things, very deſirable, even when it is not accompanied with any other thing than the light that ſtill attends it, and indears it. It hath been thought an uſeful ſecret, by a kind of retrogradation to turn tin and lead into brittle bodies, like the ores of thoſe metals. And if I thought it proper, I could ſhew, that ſuch a change might be of uſe in the inveſtigation of the nature of thoſe metals, beſides the practical uſe, that I know may be made of it. To find the nature of wine, we are aſſiſted, not only by the methods of obtaining from it a ſpirit, but by the ways of readily turning it into vinegar; the knowledge of which ways hath not been deſpiſed by chemiſts or phyſicians, and hath at *Paris*, and divers other places, ſet up a profitable trade. It is well known, that divers eminent ſpagyriſts have reckoned, amongſt their higheſt arcana, the ways, by which they pretended, (and I fear did but pretend) to extract the mercury of gold, and conſequently deſtroy that metal; and it were not hard to ſhew, by particular inſtances, that all the experiments, wherein bodies are in ſome reſpects deteriorated, are not without diſtinction to be rejected or deſpiſed; ſince in ſome of them, the light they may afford may more than countervail the degradation of a ſmall quantity of matter, though it be gold itſelf. And indeed, (continues he) if we will conſider things as philoſophers, and look upon them as nature hath made them, not as opinion hath diſguiſed them; the prerogatives and uſefulneſs of gold, in compariſon of other metals, is nothing near ſo great as alchymiſts and uſurers imagine. For, as it is true, that gold is more ponderous, and more fix'd, and perhaps more difficult to be ſpoiled, than iron; yet the qualities (whereof the firſt makes it burthenſome, and the two others ſerve chiefly but to diſtinguiſh the true from counterfeit) are ſo balanced by the hardneſs, ſtiffneſs, ſpringineſs, and other uſeful qualities of iron; that if thoſe two metals I ſpeak of (gold and iron) were equally plentiful in the world, it is ſcarce to be doubted, but that men would prefer the more uſeful before the more ſplendid, conſidering how much worſe it were for mankind to want hatchets, and knives and ſwords, than coin and plate. Wherefore, (concludes he) I think

Pyrophilus ought to be both deſired and incouraged to go on with his intended diſcourſe, ſince whether gold be or not be the beſt of metals; an aſſurance, that it may be degraded, may prove a novelty very inſtructive, and perhaps more ſo than the tranſmutation of a baſer metal into a nobler. For I remember it hath long paſſed for a maxim among chemical philoſophers, that *facilius eſt aurum conſtruere quam deſtruere*: And whatever becomes of that, it is certain, that gold being the cloſeſt, the conſtanteſt, and the leaſt deſtructible of metals, to be able to work a notable and almoſt eſſential change in ſuch a body, (though, by deteriorating it) is more than to work a like change, (though in popular eſtimation for the better) in any metal leſs indiſpoſed to admit alterations, eſpecially in ſuch an one as *Pyrophilus* intimates, by telling us, that it was made by way of projection, and conſequently by a very ſmall proportion of active matter; whereas the deſtructions, that vulgar chemiſts pretend to make of gold, are wont to be attempted to be made by conſiderable proportions of corroſive menſtruums, or other fretting bodies; and even theſe experience ſhews to be uſually too weak to ruin, though ſometime they may much diſguiſe the moſt ſtable texture of gold. *Cuncta adeo miris illic complexibus hærent.*”

Pyrophilus perceiving by ſeveral ſigns, that he needed not add any thing of apologetical to what *Ariſtander* had already ſaid for him, reſumed his diſcourſe, by ſaying, “I was going, gentlemen, when *Simplicius* diverted me, to tell you, that looking upon the vulgar objections, that have been wont to be framed againſt the poſſibility of metalline tranſmutations, from the authority and prejudices of *Ariſtotle*, and the ſchool-philoſophers, as arguments, that in ſuch an aſſembly as this need not now be ſolemnly diſcuſſed; I conſider, that the difficulties, that really deſerve to be called ſo, and are of weight even with mechanical philoſophers, and judicious naturaliſts, are principally theſe. Firſt, That the great change, that muſt be wrought by the elixir, (if there be ſuch an agent) is effected upon bodies of ſo ſtable and almoſt immutable a nature as metals. Next, That this great change is ſaid to be brought to paſs in a very ſhort time. And thirdly, (which is yet more ſtrange) that this great and ſudden alteration is ſaid to be effected by a very ſmall, and perhaps inconſiderable, proportion of the tranſmuting powder. To which three grand difficulties, I ſhall add another, that to me appears, and perhaps will ſeem to divers of the new philoſophers, worthy to be looked upon as a fourth; namely, the notable change, that muſt by a real tranſmutation be made in the ſpecifick gravity of the matter wrought upon: which difficulty I therefore think not unworthy to be added to the reſt, becauſe upon ſeveral trials of my own and other men, I have found no known quality of gold, (as its colour, malleableneſs, fixity, or the like) ſo difficult, if not ſo impoſſible, to be introduced into any other metalline matter, as the great ſpecifick gravity, that is peculiar to gold. So that, gentlemen, (concludes *Pyrophilus*) if it can be made appear, that art has produced an anti-elixir, (if I may ſo call it) or agent, that is able in a very ſhort time, to work a very notable, though deteriorating, change upon a metal; in proportion to which its quantity is very inconſiderable; I ſee not why it ſhould be thought impoſſible, that art may alſo make a true elixir, or powder capable of ſpeedily tranſmuting a great proportion of a baſer metal into ſilver or gold: eſpecially if it be conſidered, that thoſe, that treat of theſe arcana, confeſs, that it is not every matter, which may be juſtly called the philoſopher's ſtone, that is able to tranſmute other metals in vaſt quantities; ſince ſeveral of theſe writers, (and even *Lully* himſelf) make differing orders or degrees of the elixir, and acknowledge, that a medicine or tincture of the firſt or loweſt order will not tranſmute above ten times its weight of an inferior metal.

Pyrophilus having at this part of his diſcourſe made a ſhort pauſe to take breath, *Cratippus* took occaſion from his ſilence to ſay to him, “I preſume, *Pyrophilus*, I ſhall be diſavowed by very few of theſe gentlemen, if I tell you, that the company is impatient to hear the narrative of your experiment; and that if it do ſo much as probably make out the particulars you have been mentioning, you will in likelihood perſuade moſt of them, and will certainly oblige them all. I ſhall therefore on their behalf, as well as my own, ſolicite you to haſten to the hiſtorical part of a diſcourſe, that is ſo like to gratify our curioſity.”

The company having by their unanimous ſilence, teſtified their approbation of what *Cratippus* had ſaid; and appearing more than ordinarily attentive;

As I was one day abroad, ſaith *Pyrophilus*, to return viſits to my friends, I was by a happy providence (for it was beſide my firſt intention) directed to make one to an ingenious foreigner, with whom a few, that I had received from him, had given me ſome little acquaintance.

Whilst this gentleman and I were diſcourſing together of ſeveral matters, there came in to viſit him a ſtranger, whom I had but once ſeen before; and though that were in a promiſcuous company, yet he addreſſed himſelf to me in a way, that quickly ſatisfied me of the greatneſs of his civility; which he ſoon after alſo did of that of his curioſity. For the virtuoſo, in whoſe lodgings we met, having (to gratify me) put him upon the diſcourſe of his voyages; the curious ſtranger entertained us an hour or two with pertinent and judicious anſwers to the queſtions I asked him about places ſo remote, or ſo much within land, that I had not met with any of our Engliſh navigators or travellers, that had penetrated ſo far as to viſit them. And becauſe I found by his diſcourſe, that I was like to enjoy ſuch good company but a very little while, (ſince he told me, that he came the other day into *England* but to diſpatch a buſineſs, which he had already done as far as he could do it, after which he was with ſpeed to return, as (to my trouble) he did to his patron that ſent him) I made the more haſte to propoſe ſuch queſtions to him, as I moſt deſired to be ſatisfied about; and among other things, enquiring whether in the eaſtern parts he had traverſed, he had met with any chemiſts; he anſwered me, that he had; and that though they were fewer, and more reſerved than ours, yet he did not find them at all leſs skilful. And on this occaſion, before he left the town to go aboard the ſhip he was to overtake, he in a very obliging way put into my hands, at parting, a little piece of paper, folded up; which he ſaid contained all that he had left of a rarity he had received from an eaſtern virtuoſo, and which he intimated would give me occaſion both to remember him, and to exerciſe my thoughts in uncommon ſpeculations.

The great delight I took in converſing with a perſon, that had travelled ſo far, and could give me ſo good an account of what he had ſeen, made me ſo much reſent the being ſo ſoon deprived of it, that though I judged ſuch a virtuoſo would not, as a great token of his kindneſs, have preſented me a trifle, yet the preſent did but very imperfectly conſole me for the loſs of ſo pleaſing and inſtructive a converſation.

Nevertheleſs, that I might comply with the curioſity he himſelf had excited in me, and know how much I was his debtor, I reſolved to ſee what it was he had given me, and try whether I could make it do what I thought he intimated, by the help of thoſe few hints rather than directions how to uſe it, which the parting haſte he was in (or perhaps ſome other reaſon beſt known to himſelf) confined him to give me. But in regard that I could not but think the experiment would one way or other prove extraordinary, I thought fit to take a witneſs or two and an aſſiſtant in the trying of it; and for that purpoſe made choice of an experienced doctor of phyſick, very well verſed in the ſeparating and copelling of metals.

Though the company, ſays *Heliodorus*, be ſo confident of your ſincerity and warineſs, that they would give credit even to unlikely experiments, upon your ſingle teſtimony; yet we cannot but approve your diſcretion in taking an aſſiſtant and a witneſs, becauſe in nice and uncommon experiments we can ſcarce uſe too much circumſpection, eſpecially when we have not the means of reiterating the trial: for in ſuch new, as well as difficult caſes, it is eaſy, even for a clear-ſighted experimenter to over-look ſome important circumſtance, that a far leſs skilful by-ſtander may take notice of.

As I have ever judged, ſaith *Pyrophilus*, that cautiouſneſs is a very requiſite qualification for him, that would ſatisfactorily make curious experiments; ſo I thought fit to imploy a more than ordinary meaſure of it, in making a trial, whoſe event I imagined might prove odd enough. And therefore having ſeveral times obſerved, that ſome men are prepoſſeſſed, by having a particular expectation raiſed in them, and are inclined to think, that they do ſee that happen, which they think they ſhould ſee happen; I reſolved to obviate this prejudication as much as innocently I could, and (without telling him any thing but the truth, to which philoſophy, as well as religion, obliges us to be ſtrictly loyal) I told him but thus much of the truth, that I expected, that a ſmall proportion of a powder preſented me by a foreign virtuoſo would give a brittleneſs to the moſt flexible and malleable of metals, gold itſelf. Which change I perceived he judged ſo conſiderable and unlikely to be affected, that he was greedy of ſeeing it ſeverely tried.

Having thus prepared him not to look for all that I my ſelf expected, I cautiouſly opened the paper I lately mentioned, but was both ſurprized and troubled (as he alſo was) to find in it ſo very little powder, that inſtead of two differing trials, that I deſigned to make with it, there ſeemed very ſmall hope left, that it would ſerve for one (and that but an imperfect one neither.) For there was ſo very little powder, that we could ſcarce ſee the colour of it (ſave that, as far as I could judge, it was of a darkiſh red) and we thought it not only dangerous, but uſeleſs to attempt to weigh it, in regard we might eaſily loſe it by putting it into, and out of the balance; and the weights we had were not ſmall enough for ſo deſpicable a quantity of matter; which in words I eſtimated at an eighth part of a grain; but my aſſiſtant (whoſe conjecture I confeſs my thoughts inclined to prefer) would allow it to be at the moſt but a tenth part of a grain. Wherefore ſeeing the utmoſt we could reaſonably hope to do with ſo very little powder, was to make one trial with it, we weighed out in differing balances two drams of gold, that had been formerly Engliſh coin, and that I cauſed by one, that I uſually imploy, to be cupelled with a ſufficient quantity of lead, and quarted, as they ſpeak, with refined ſilver, and purged aqua fortis, to be ſure of the goodneſs of the gold. Theſe two drams I put into a new crucible, firſt carefully nealed, and having brought them to fuſion by the meer action of the fire, without the help of borax, or any other additament (which courſe, though ſomewhat more laborious than the moſt uſual, we took to obviate ſcruples) I put into the well-melted metal with my own hand the little parcel of powder lately mentioned, and continuing the veſſel in the fire for about a quarter of an hour, that the powder might have time to diffuſe itſelf every way into the metal, we poured out the well-melted gold into another crucible that I had brought with me, and that had been gradually heated before to prevent cracking. But though from the firſt fuſion of the metal to the pouring out, it had turned in the crucible like ordinary gold, ſave that once my aſſiſtant told me, he ſaw that for two or three moments it looked almoſt like an opale; yet I was ſomewhat ſurprized to find, when the matter was grown cold, that though it appeared upon the balance, that we had not loſt any thing of the weight we put in, yet, inſtead of fine gold, we had a lump of metal of a dirty colour, and as it were overcaſt with a thin coat, almoſt like half vitrified litharge; and ſomewhat to increaſe the wonder, we perceived, that there ſtuck to one ſide of the crucible a little globule of metal, that looked not at all yellowiſh, but like coarſe ſilver, and the bottom of the crucible was overlaid with a vitrified ſubſtance, whereof one part was of a tranſparent yellow, and the other of a deep brown, inclining to red; and in this vitrified ſubſtance I could plainly perceive ſticking at leaſt five or ſix little globules, that looked more like impure ſilver than pure gold. In ſhort, this ſtuff looked ſo little like refined, or ſo much as ordinary, gold, that though my friend did much more than I marvel at this change, yet I confeſs I was ſurprized at it myſelf. For though in ſome particulars it anſwered what I looked for, yet in others, it was very differing from that, which the donor of the powder had, as I thought, given me ground to expect. Whether the cauſe of my diſappointment were, that (as I formerly intimated) this virtuoſo's haſte or deſign made him leave me in the dark; or whether it were, that finding myſelf in want of ſufficient directions, I happily pitched upon ſuch a proportion of materials and way of operating, as were proper to make a new diſcovery, which the excellent giver of the powder had not deſigned, or perhaps thought of.

I SHALL not at all wonder, ſaith *Cratippus*, either at your friend's amazement, or at your ſurprize, if your further trials did in any meaſure confirm what the ſuperficial change, that appeared in your metal, could not but incline you to conjecture.

You will beſt judge of that (replies *Pyrophilus*) by the account I was going to give you of what we did with our odd metal. And firſt, having rubbed it upon a good touchſtone, whereon we had likewiſe rubbed a piece of coined ſilver, and a piece of coined gold, we manifeſtly found, that the mark left upon the ſtone by our maſs, between the marks of the two other metals, was notoriouſly more like the touch of the ſilver than that of the gold. Next, having knocked our little lump with a hammer, it was (according to my prediction) found brittle, and flew into ſeveral pieces. Thirdly (which is more) even the inſides of thoſe pieces looked of a baſe dirty colour, like that of braſs or worſe, for the fragments had a far greater reſemblance to bell-metal, than either to gold or to ſilver. To which we added this fourth, and more conſiderable examen; that having carefully weighed out one dram of our ſtuff (reſerving the reſt for trials to be ſuggeſted by ſecond thoughts) and put it upon an excellent new and well-nealed coppel, with about half a dozen times its weight of lead, we found, ſomewhat to our wonder, that though it turned very well like good gold, yet it continued in the fire above an hour and an half (which was twice as long as we expected) and yet almoſt to the very laſt the fumes copiouſly aſcended, which ſufficiently argued the operation to have been well carried on; and when at laſt it was quite ended, we found the coppel very ſmooth and intire, but tinged with a fine purpliſh red (which did ſomewhat ſurprize us;) and beſides, the refined gold, there lay upon the cavity of the coppel ſome dark-coloured recrements, which we concluded to have proceeded from the deteriorated metal, not from the lead. But when we came to put our gold again into the balance, we found it to weigh only about fifty three grains, and conſequently to have loſt ſeven; which yet we found to be fully made up by that little quantity of recrements, that I have lately mentioned, whoſe weight and fixity, compared with their unpromiſing colour, did not a little puzzle us, eſpecially becauſe we had not enough either of them, or of leiſure, to examine their nature. To all which circumſtances I ſhall ſubjoin this, that to prevent any ſcruples, that might ariſe touching the gold we employed, I cauſed a dram and a half, that had been purpoſely reſerved out of the ſame portion with that, which had been debaſed; I cauſed this (I ſay) to be in my aſſiſtant's preſence melted by itſelf, and found it (as I doubted not but I ſhould do) fine and well-coloured gold.

I HOPE you will pardon my curioſity, ſaith *Ariſtander* to the gentleman that ſpoke laſt, if I aſk, why you take no notice of the effect of aqua fortis upon your imbaſed metal? Your queſtion, replies *Pyrophilus*, I confeſs to be very reaſonable, and I am ſomewhat troubled, that I cannot anſwer it but by telling you, that we had not at hand any aqua fortis we durſt rely on; which yet I was the leſs troubled at, becauſe heretofore ſome trials purpoſely made had informed me, that in ſome metalline mixtures the gold, if it were much predominant in quantity, may protect another metal, (for inſtance ſilver,) from being diſſolved by that menſtruum, though not from being at all invaded by it.

THERE yet remained, ſaith *Heliodorus*, one examen more of your odd metal, which would have ſatisfied me, at leaſt as much as any of the reſt, of its having been notably imbaſed: for if it were altered in its ſpecifick gravity, that quality I have always obſerved (as I lately perceived you alſo have done) to ſtick ſo cloſe to gold, that it could not by an additament ſo inconſiderable in point of bulk, be conſiderably altered without a notable and almoſt eſſential change in the texture of the metal.

To this pertinent diſcourſe, *Pyrophilus*, with the reſpect due to a perſon, that ſo worthily ſuſtained the dignity he had of preſiding in that choice company, made this return: I owe you, ſir, my humble thanks for calling upon me to give you an account I might have forgotten, and which is yet of ſo important a thing, that none of the other phænomena of our experiment ſeemed to me to deſerve ſo much notice. Wherefore I ſhall now inform you, that having provided my ſelf of all the requiſites to make hydroſtatical trials (to which perhaps I am not altogether a ſtranger) I carefully weighed in water the ill-looked maſs (before it was divided for the coppelling of the above-mentioned dram) and found, to the great confirmation of my former wonder and conjectures, that inſtead of weighing about nineteen times as much as a bulk of water equal to it, its proportion to that liquor was but that of fifteen and about two thirds to one: ſo that its ſpecific gravity was leſs by about $\frac{1}{5}$ than it would if it had been pure gold.

At the recital of this notable circumſtance, ſuperadded to the reſt, the generality of the company, and the preſident too, by looking and ſmiling upon one another, expreſſed themſelves to be as well delighted as ſurprized; and after the murmuring, occaſioned by the various whiſpers that paſſed amongſt them, was a little over, *Heliodorus* addreſſed himſelf to *Pyrophilus*, and told him; I need not, and therefore ſhall not, ſtay for an expreſs order from the company to give you their hearty thanks: for as the obliging ſtranger did very much gratify you by the preſent of his wonderful powder, ſo you have not a little gratified us by ſo candid and particular a narrative of the effects of it; and I hope (continues he) that if you have not yet otherwiſe diſpoſed of that part of your deteriorated gold that you did not coppel, you will ſometime or other favour us with a ſight of it.

I join in this requeſt, ſaid *Cratippus*, as ſoon as he perceived the preſident had done ſpeaking; and to facilitate the grant of it, I ſhall not ſcruple to tell *Pyrophilus*, he may be confident, that the degradation of his gold will not depreciate it amongſt us: ſince if it be allowable for opinion to ſtamp ſuch a value upon old coins and medals, that in the judgment of good antiquaries, a ruſty piece of braſs or copper, with a half defaced image or inſcription on it, is to be highlier valued than as big a piece of well-ſtamped gold; I ſee not, why it ſhould not be lawful for philoſophers to prize ſuch a lump of depraved gold as yours before the fineſt gold the chymiſts or mint-maſters are wont to afford us. And though I freely grant, that ſome old copper medals are of good uſe in hiſtory, to keep alive by their inſcriptions the memory of the taking of a town, or the winning of a battle; though theſe be but things, that almoſt every day are ſome where or other done, yet I think *Pyrophilus*'s imbaſed metal is much to be preferred, as not only preſerving the memory, but being an effect of ſuch a victory of art over nature, and the conquering of ſuch generally believed inſuperable difficulties, as no ſtory that I know of gives us an example of.

As ſoon as ever *Cratippus* had made a pauſe, *Pyrophilus*, to prevent complimental diſcourſe, did in a few words tell the preſident, that his part had been but that of a relator of matter of fact; and that therefore he could deſerve but little thanks and no praiſe at all; though a good meaſure of both of them were due to the obliging virtuoſo, that had given him the powder; and in that, the opportunity of complying with his duty, and his inclination, to ſerve that learned company.

These gentlemen, ſaith *Ariſtander*, are not perſons, among whom modeſty is either reſtrained from expreſſing itſelf, or conſtrued according to the letter; and therefore whatever you have been pleaſed to ſay, the company cannot but think itſelf much obliged to you; and I know the obligation would be much increaſed, if you would favour us with your reflections upon the extraordinary experiment you have been pleaſed to relate to us.

If, replies *Pyrophilus*, I had had wherewithal to repeat the experiment, and vary it according to the hints afforded me by the firſt trial, I ſhould be leſs unfit to comply with *Ariſtander*'s motion: but the phænomena are too new and too difficult for me to attempt to unriddle them by the help of ſo ſlender an information as a perſon ſo little ſagacious as I could get by a ſingle trial; and though I will not deny, that I have had ſome roving thoughts about this puzzling ſubject, yet I hope I ſhall be eaſily pardoned, if I decline to preſent crude and immature thoughts to a company, that ſo well deſerve the moſt ripe ones, and can ſo ſkilfully diſcover thoſe that are not ſo.

I confess, ſaith *Heliodorus*, that I think *Pyrophilus*'s warineſs deſerves, not only to be allowed, but imitated; and therefore by my conſent the further diſcourſe of ſo abſtruſe a ſubject ſhall be deferred, till we ſhall have had time to conſider ſeriouſly of phænomena, that will be ſure to employ our moſt ſpeculative thoughts, and I fear to poſe them too: only we muſt not forget, that *Pyrophilus* himſelf ought to be not barely allowed, but invited to draw, before we riſe, what corollaries he thinks fit to propoſe from what he hath already delivered.

The inference, ſaid *Pyrophilus*, I meant to make, will not detain you long; having for the main been already intimated in what you may remember I told you I deſigned in the mention I was about to make of the now recited experiment. For without launching into difficult ſpeculations, or making uſe of diſputable hypotheſes, it ſeems evident enough from the matter of fact faithfully laid before you, that an operation very near, if not altogether as ſtrange as that, which is called projection, and in the difficulteſt points much of the ſame nature with it, may ſafely be admitted. For our experiment plainly ſhews, that gold, though confeſſedly the moſt homogeneous, and the leaſt mutable of metals, may be in a very ſhort time (perhaps not amounting to many minutes) exceedingly changed, both as to malleableneſs, colour, homogeneity, and (which is more) ſpecific gravity; and all this by ſo very inconſiderable a portion of injected powder, that ſince the gold that was wrought on weighed two of our Engliſh drams, and conſequently an hundred and twenty grains, an eaſy computation will aſſure us, that the medicine did thus powerfully act, according to my eſtimate (which was the modeſteſt) upon near a thouſand times (for it was above nine hundred and fifty) its weight of gold, and according to my aſſiſtant's eſtimate, did (as they ſpeak) go near upon twelve hundred; ſo that if it were fit to apply to this anti-elixir (as I formerly ventured to call it) what is ſaid of the true elixir by divers of the chymical philoſophers, who will have their virtue of their ſtone increaſed in ſuch a proportion, as that at firſt it will tranſmute but ten times its weight, after the next rotation an hundred times, and after the next to that a thouſand; our powder may in their language be ſtiled a medicine of the third order.

The computation, ſaith *Ariſtander*, is very obvious, but the change of ſo great a portion of metal is ſo wonderful and unexampled, that I hope we ſhall among other things learn from it this leſſon, that we ought not to be ſo forward, as many men otherwiſe of great parts are wont to be, in preſcribing narrow limits to the power of nature and art, and in condemning and deriding all thoſe that pretend to, or believe, uncommon things in chymiſtry, as either cheats or credulous. And therefore I hope, that though (at leaſt in my opinion) it be very allowable to call fables, fables, and to detect and expoſe the impoſtures or deceits of ignorant or vain-glorious pretenders to chymical myſteries; yet we ſhall not, by too haſty and general cenſures of the ſober and diligent inveſtigators of the arcana of chymiſtry, blemiſh (as much as in us lies) that excellent art itſelf, and thereby diſoblige the genuine ſons of it, and divert thoſe, that are indeed poſſeſſors of noble ſecrets, from vouchſafing to gratify our curioſity, as we ſee that one of them did *Pyrophilus*'s, with the ſight at leaſt of ſome of their highly inſtructive rarities.

I WHOLLY approve, ſaith *Heliodorus* riſing from his ſeat, the diſcreet and ſeaſonable motion made by *Ariſtander*.

AND I preſume, ſubjoins *Pyrophilus*, that it will not be the leſs liked, if I add, that I will allow the company to believe, that as extraordinary, as I perceive moſt of you think the phænomena of the lately recited experiment; yet I have not (becauſe I muſt not do it) as yet acquainted you with the ſtrangeſt effect of our admirable powder.

THE

AERIAL NOCTILUCA:

OR, SOME

NEW PHÆNOMENA,

AND A

PROCESS of a factitious ſelf-ſhining SUBSTANCE.

AN ADVERTISEMENT of the PUBLISHER to the READER.

THE honourable author of the following papers, thinking it probable, that the proceſſes delivered in them, having hitherto been publiſhed by no man, will, as well for that reaſon, as for the nobleneſs of the ſubject, prove not unwelcome to the curious, in divers countries, where Engliſh is not underſtood: he was very willing, for their ſakes, that this tract ſhould be turned into Latin. And now, to prevent the needleſs pains of any, that may have a mind to make ſuch a verſion, without having the opportunity to conſult the author, upon any doubt of his meaning, I think fit to give notice, that the tranſlation is, by the author's conſent, made already, and, God permitting, will quickly appear in public. Perhaps it will not be improper to add, that the reaſon, why the following Engliſh tract is printed in octavo (as they ſpeak) is, that it may be conveniently bound up, either with the notes, already publiſhed in the ſame form about divers particular qualities, or with thoſe other notes, that yet remain to be publiſhed about other qualities; to whoſe number light and inflammability may be referred. The enſuing diſcourſe having been written to a virtuoſo living in the country, who has been for many years abſent from London, it was thought fit in the beginning of theſe papers to give him ſome informations about phoſphorus's, and their ſeveral kinds in general; but it was not thought fit to publiſh at the beginning of the letter any thing of compliment; ſince in that, neither the main ſubject, nor the reader, was concern'd.

To my very learned Friend Dr. J. B.

SIR,

TO gratify your curioſity about phoſphorus's, as much as I can without indiſcretion at preſent do, I muſt, in the firſt place, take notice to you, that though phoſphorus's may well be diſtinguiſhed into two ſorts; thoſe that may be ſtiled natural, as glow-worms, ſome ſorts of rotten wood and fiſhes, and a few others; and thoſe that are properly artificial: yet waving, at preſent, further mention of the former ſort of bodies, that without manifeſt heat ſhine in the dark (which abſence of ſenſible heat diſtinguiſhes phoſphorus's from common fire and flame;) I ſhall now confine my diſcourſe to the latter ſort, and tell you, that as far as I have hitherto obſerved, thoſe factitious ſhining bodies, that do or may paſs under the name of phoſphorus's, may be reduced to two principal kinds, one of which may be ſubdivided into two or three, ſo that in all they will amount to three or four.

THE firſt of theſe conſiſts of ſuch bodies, as ſhine only by the help of external illuſtration, or (if you pleaſe) ſuch bodies, as being expoſed to the beams of the ſun, or thoſe of a vigorous flame, will retain a lucidneſs, and continue to ſhine ſome time in the dark. Of this kind is the Bolonian ſtone, ſkilfully prepared; and of this ſort alſo is the Phoſphorus Hermeticus of Balduinus, of whoſe phœnomena, but not the way of making it, the author has given the learned world an account. This phoſphorus was therefore very welcome to divers of the curious, becauſe the Bolonian ſtone was for ſome years before grown very rare, even in its own country, *Italy*, which ſcarceneſs, an ingenious traveller, then lately come out of thoſe parts, told me he imputed to the death of the perſon, that uſed to prepare the ſtone at *Bologna*, without having left a ſufficient account of his way of making it lucid. And the phoſphorus of Balduinus, which, or the like, may be made (as I have tried) both of chalk, and another ſubſtance, ſeemed to me, when the preparation ſucceeded beſt, to catch the external light (if I may ſo ſpeak) far more readily than the Bolonian ſtone: for I remember I have had one, that being freſhly made, would within about half a minute of an hour be manifeſtly excited, and as it were kindled; ſo that being preſently removed into a dark place, it would retain a very ſenſible light, for ſo many times as long as it had been expoſed to the beams of the external light; and this (if I much miſremember not) was even when that external light was but the flame of a candle.

BUT, on the other ſide, whereas I have more than once or twice obſerved, with trouble, that theſe phoſphorus's could very hardly be preſerved for any long time (which I was apt to impute to the action of the inſinuating air) ſo that ſome of them in not many months, and others even in a few weeks (or perhaps days) would appear cracked, and loſe their vertue of being excited by the beams of light; the Bolonian ſtone, ſkilfully prepared, would retain its virtue for a much longer time: for I remember (whatever learned men have delivered to the contrary) I had a ſmall piece of it, which, though I kept it negligently enough in an ordinary little wooden box, retained its vertue for ſeveral years after I had it, which was not till a great while after it was firſt prepared. What I have further obſerved concerning the Phoſphorus Hermeticus, I have not now the leiſure to acquaint you with.

BUT beſides this firſt kind of phoſphorus's, that, to be able to ſhine, muſt have their faculty excited by the beams of the ſun, or thoſe of ſome other actually ſhining body: there is another ſort, which needs not be previouſly illuſtrated by any external lucid, and yet continues to ſhine far longer than the Bolonian ſtone, or the phoſphorus of Balduinus. This by ſome learned men has been called, to diſcriminate it from the former, a noctiluca; which, though in ſtrictneſs I cannot think it as proper a name as could be wiſhed, ſince the other phoſphorus will ſhine in the night as well as the day, if it be excited with the flame of a culinary fire, or of a large candle; yet ſince the name has been received by ſeveral, and ſince it is not eaſy in our language to expreſs the thing clearly in one word, I ſhall (though for brevity, as much as diſtinction-ſake) admit the uſe of this name, yet without forbearing ſometimes to ſubſtitute for it that of a ſelf-ſhining ſubſtance, which is more expreſſive of its nature. Of this ſubſtance Mr. *Daniel Kraft*, a German Chymiſt, ſhewed his majeſty two ſorts or degrees. To the firſt of which I took the liberty to give the name of conſiſtent (or gummous) noctiluca, not in that ſenſe, wherein the word is oppoſed to ſoft, for this ſubſtance was at leaſt as yielding as bees-wax in ſummer; but as the word conſiſtent is employed as equivalent to firm, and oppoſed to liquid and fluid. By reaſon alſo of its ſomewhat viſcous texture, not very unlike that of gum of cherries, and ſome others newly taken from the tree, it may be called the gummous noctiluca: and, I am informed, that on the ſcore of its uninterrupted action, it is called by ſome in *Germany*, the conſtant noctiluca; which title it does not ill deſerve, ſince this phoſphorus is much the nobleſt we have yet ſeen. For though there were not much of it, and though it were kept by itſelf in a little vial, well ſtopped, it would, without being externally excited, inceſſantly ſhine, as he affirmed, both day and night. Yet the light it afforded ſeemed but little, if at all, more vivid, than I have ſometimes obſerved in the liquor of glow-worms, and ſome other phoſphorus's of nature's producing: nor had the poſſeſſor enough of this ſubſtance to invite his conſent to any trial to improve it, the quantity he had at *London* ſcarce exceeding in bulk the kernel of an almond.

BESIDES this gummous noctiluca, Mr. *Kraft* had a liquid one, that, perhaps, was made only by diſſolution of the former in water, or ſome convenient liquor; but the lucidneſs of this was not permanent like that of the other, as I have noted in another paper; but within no very long time, eſpecially when it was divided into ſmaller portions, and left expoſed to the air, would expire or vaniſh.

BUT beſides the gummous and the liquid noctiluca hitherto mentioned, I know not whether we may not add a third kind, that we our ſelves lately prepared, which ſeems to be of a ſomewhat differing nature, both from the conſiſtent, and the liquid noctiluca newly deſcribed, at leaſt as far as I obſerved their phænomena. For this of ours would not ſhine of itſelf, like the conſtant noctiluca, nor yet in that manner, that the liquid noctiluca did; but the bare contact of the air, without any external illuſtration or heat, would immediately produce a light (which might eaſily be made to laſt a good while in a well ſtopped veſſel;) and, which is conſiderable, the ſubſtance, that ſhined, was not the body of the liquor included in the vial, but an exhalation or effluvium mingled with the admitted air: for both which reaſons, I gave it the name of Aerial Noctiluca.

THESE are the ſeveral phoſphorus's, that I have yet had opportunity to ſee; but, for ought I know, their variety may extend ſomewhat further, becauſe I have heard of a paper printed in *Germany* by an ingenious man, whoſe name (if I miſtake not) is *Elſholez*, wherein particular mention is made, in an hiſtorical way, of the German Noctiluca: but this paper I cannot yet procure, and therefore you would do well to conſult it, if you can get it; and I am not averſe from thinking, that future induſtry may diſcover ſome new kinds or variations of ſelf-ſhining ſubſtances, that will deſerve new names, and among them, perhaps, that of ſolid Noctiluca's.

HAVING ſaid thus much of the ſeveral ſorts of artificial phoſphorus's, I ſhall be very brief in ſpeaking of their inventors, whereof I have but an imperfect information. For though I find it generally agreed, that the Phoſphorus Hermeticus was firſt found and publiſhed to the world by the learned and ingenious *Balduinus*, a German lawyer; yet as to the gummous and liquid noctiluca's, I find the firſt invention is by ſome aſcribed to the abovementioned Mr. *Krafft*, (though I remember not, that when he was here, he plainly aſſerted it to himſelf;) by others, attributed to an antient chymiſt, dwelling at *Hamburgh*, whoſe name (if I miſtake not) is Mr. *Brane*, and by others again, with great confidence, aſſerted to a famous German chymiſt in the court of *Saxony*, called *Kunckelius*. But to which of theſe ſo noble an invention, as that of the two German noctiluca's, is juſtly due, I neither am qualified nor deſirous to judge; and therefore, without prejudicing any man's right, I will proceed to that, which, I preſume, is the chief thing you would know of me, namely, *An account of the occaſion and ſteps of my own attempt to make a Noctiluca.* Concerning this I ſhall give you the following narrative, wherein, though my urgent avocations will not (I fear) permit me to be other than immethodical, yet I ſhall not decline to mention ſome circumſtances, that I know may be omitted, becauſe they will not, perhaps, be found ſo barely hiſtorical, but that they may prove of ſome uſe to a leſs ſagacity than yours, in an enquiry into a ſubject, wherein I cannot yet plainly tell you all you could wiſh to know, and which is both new and abſtruſe, as well as noble.

AFTER the experienced chymiſt Mr. *Daniel Krafft* had, in a viſit that he purpoſely made me, ſhewn me and ſome of my friends, both his liquid and conſiſtent phoſphorus, being by the phænomena I then obſerved, (and whereof the curious have ſince had publick notice *,) made certain, that there is really ſuch a factitious body to be made, as would ſhine in the dark, without having been before illuſtrated by any lucid ſubſtance, and without being hot as to ſenſe: after this, I ſay, I took into conſideration, by what ways it might be moſt probable, to produce, by art, ſuch a ſhining ſubſtance. To ſeek for which I was both inclined, and hopeful to be ſomewhat aſſiſted, becauſe I had lying by me, among my yet unpubliſhed notes of the mechanical origin of divers qualities, a collection of ſome obſervations and thoughts concerning light. And I was alſo the more encouraged to attempt ſomewhat this way, becauſe having, at Mr. *Krafft*'s deſire, imparted to him ſomewhat, that I diſcovered about uncommon mercuries, (which I had then communicated but to one perſon in the world) he, in requital, confeſt to me at parting, that at leaſt the principal matter of his phoſphorus was ſomewhat that belonged to the body of man. This intimation, though but very general, was therefore very welcome to me, becauſe, though I have often thought it probable, that a ſhining ſubſtance may, by chymical art, be obtained from more kinds of bodies than one: yet deſigning in the firſt place to try, if I could hit upon ſuch a phoſphorus as I ſaw was preparable, the advertiſement ſaved me (for ſome time) the labour of ranging among various bodies, and directed me to exerciſe my induſtry in a narrower compaſs. But there being divers parts of the human body, that have been taken to task by chymiſts, and, perhaps, by me as carefully, as by ſome others, my choice might have been diſtracted between the blood, the ſolid excrements, the bones, the urine, and the hair, of the human body; if various former trials and ſpeculations upon more than one of thoſe ſubjects had not directed me to pitch upon that, which was fitteſt to be choſen, and of which, as I had formerly ſet down divers experiments and obſervations, ſo I had made proviſion of a quantity of it, and ſo far prepared it, that it wanted but little of being fit for my preſent purpoſe. But before I had made any great progreſs in my deſign, I was by divers removes, indiſpoſitions of body, law-ſuits, and other avocations, ſo diſtracted, or at leaſt diverted, that I laid aſide the proſecution of the phoſphorus for a long time. And when afterwards I reſumed it, though I wrought upon the right matter, yet I was diverted from the right way, by a proceſs that I received from beyond ſea, as a great arcanum, that would certainly produce the noctiluca aſpired to; for partly upon this account, but more, becauſe I ſaw that the chief ingredient in this proceſs was that, which I, with reaſon, took to be the beſt matter, I was induced to purſue the preſcribed method for ſome months, but without ſucceſs; the true matter being, as I concluded, too much either altered or clogged by the additional ingredients, that were deſigned to improve it; beſides, that the degree of fire, though a circumſtance of the greateſt moment, was overlooked, or not rightly preſcribed. However, adhering to the firſt choice I had made of a fit matter, I did not deſiſt to work upon it by the ways I judged the moſt hopeful, when a learned and ingenious ſtranger, (*A. G.* M. D. countryman, if I miſtake not, to Mr *Krafft*) who had newly made an excurſion into *England*, to ſee the country, having, in a viſit he was pleaſed to make me, occaſionally diſcourſed, among other things, about the German noctiluca, whereof he ſoon perceived I knew the true matter, and had wrought much upon it; he ſaid ſomething about the degree of fire, that made me afterwards think, when I reflected on it, that that was the only thing I wanted to ſucceed in my endeavors. And there was the more reaſon to think ſo, becauſe for want of a due management of the fire, we had divers times failed of making the phoſphorus of *Balduinus*, not only after we had more than once wrought upon the right matter, but after we had actually made the phoſphorus. Wherefore when we left *London*, having yet ſome quantity of the matter in ſuch readineſs, that it needed but the fire to let me ſee, what I ought to think of the hint the ingenious traveller had given me, I cauſed the trial to be renewed, which, proving unſucceſsful, diminiſhed much of my ſtock of prepared matter, but it did not ſo diſcourage me, as to hinder me from reiterating the attempt (without much varying it) with a good part of what remained. And though at this time alſo all the care and diligence, that could be employed, did not hinder an unlucky miſcarriage, that kept the trial from being fully ſatisfactory; yet being confident upon the nature of the thing, I would not believe the ſkilful laborant, when he told me with trouble, that what I expected, was not at all produced: but going myſelf to the laboratory, I quickly found, that by the help of the air, or ſome agitation of what had paſſed into the receiver, I could, in a dark place (though it was then day) perceive ſome glimmerings of light, which, you will eaſily believe, I was not ill pleaſed to ſee. And now you have the hiſtory of my purſuit of the liquid phoſphorus, that has made ſome noiſe among the curious: but I freely confeſs, that the ſucceſs, though welcome, was not ſo full as I aimed at, for I obtained no ſuch conſiſtent phoſphorus as that, whereof Mr. *Krafft* ſhewed me, as I formerly told you, a ſmall parcel. But as I was willing to think, that this defect may be imputed to the cracking of the retort, before the operation was quite finiſhed, ſo I hope another diſtillation in a more luckily choſen veſſel may make me amends for the newly mentioned miſcarriage, and thereby enable me to diſcover other, and perhaps nobler phænomena of our ſhining ſubſtance, than hitherto I have been able to obſerve. Eſpecially conſidering, that the ſame misfortune, that I hope was the principal cauſe of my miſſing the nobleſt thing I aimed at, the conſtant noctiluca, left me ſo little even of liquid matter, fit for my purpoſe, that I have not dared, for fear of waſting it, to try ſeveral things with it, that I preſume may be of good uſe in an enquiry into the nature of this light, and perhaps alſo of light in general. And becauſe I fear by what I have obſerved, that, though the veſſel had not cracked, yet the matter diſtilled would have afforded but a ſmall proportion of lucid ſubſtance, I am the more unwilling to fall upon this troubleſome work again, till, beſides other requiſites, I be provided of a competent quantity of a matter, which I fear contains but very little of the deſired ſubſtance. However, I have endeavoured to make that uſe of our experiment, ſuch as it was, that though the noctiluca it produced, be not perhaps ſo lucid as that of Mr. *Krafft's*, yet it may prove as luciferous as his hath hitherto been, ſince

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* This clauſe refers to one of the *Philoſophical Collections* publiſhed by the ingenious Mr. *Hook*, who hath therein inſerted *verbatim* the paper he received from Mr. *Boyle*.

(as you will ſee hereafter) I have found a ſubſtance, that needs the air, and nothing but the air to kindle it, and that in a moment.

In this narrative I have been the more particular, that it may ſhew you, (what I hope may make you amends for the length of it) that an inquiſitive man ſhould not always be deterred by the difficulties, or even diſappointments he may meet with, in proſecuting a noble experiment, as long as he judges himſelf to proceed upon good and rational grounds.

The uſes, that may be made of noctiluca's, eſpecially of the conſiſtent, are not, in probability, all of them to be eaſily foreſeen and declared; eſpecially by me, who have not yet had time and ability to make thoſe improvements of ſelf-ſhining ſubſtances, that, by the aſſiſtance of the father of lights, I hope will, in proceſs of time, be attained. If the lucid vertue of the conſtant noctiluca could be (as I ſee not, why it may not be) conſiderably invigorated, it may prevent a great deal of danger, to which men of war, and other ſhips are expoſed, by the neceſſity men often have to come into the gun-room with common flame or fire, to take out powder, which has occaſioned the blowing up of many a brave ſhip. Our light may, perhaps, be of uſe to thoſe, that dive in deep waters; and alſo may very ſafely and conveniently be let down into the ſea, to what depth one pleaſes, and kept there a long time, to draw together the fiſhes, that are wont to reſort to the light of a fire or candle; as in divers parts of *Scotland* and *Ireland* is well known to the fiſhermen, who get much profit by this reſort. The ſame ſelf-ſhining ſubſtance, which in our aërial noctiluca affords a light, that, as faint as it yet is, was able, when I waked in the night, to ſhew me diſtinctly enough the bigneſs and ſhape of ſome joints of my fingers, and to diſcover itſelf in the ſhape of a capital letter of the alphabet, that was cut out of a piece of blacked paper paſted upon the vial; this light, I ſay, may probably, (at leaſt when ſomewhat invigorated) ſuffice to ſhew the hour of the night when one wakes, (with eyes unaccuſtomed to light) if it be placed, inſtead of a lamp or candle, behind an index, where the figures employed to mark the hours are cut out. It may alſo ſerve to make a guide knowable at a good diſtance off, in ſpite of tempeſtuous winds and great ſhowers, and this in the darkeſt night. Divers ludicrous experiments, very pleaſant and ſurprizing, may be made with the noctiluca, by him that has enough of it. But theſe trifles, though very pretty in their kind, I purpoſely paſs over: as alſo an uſe, that may be of great, but I fear of miſchievous, conſequence; reſerving what I have further to ſay of the uſefulneſs of theſe ſelf-ſhining ſubſtances, till time ſhall give me more information and leiſure. In the mean while I ſhall only intimate, that probably the utilities, that ſo ſubtle and noble a ſubſtance may be brought to afford in medicine, may be more conſiderable than any of its other particular uſes; and that though our noctiluca had none of theſe, yet it may be highly valuable, if it ſhall (as in all likelihood it will) be found conducive to diſcover the nature of ſo noble a ſubject, as light, whoſe encomiums would require more time than I can allow this writing. And perhaps they will ſeem needleſs, when I ſhall have obſerved, that light was the firſt corporeal thing the great creator of the univerſe was pleaſed to make; and that (as our excellent *Bacon* has well noted, to another purpoſe) he was pleaſed to allot the whole firſt day to the creation of light alone, without aſſociating with it in that honour any other corporeal thing.

These things being premiſed, I ſhall proceed to what I chiefly intended in this paper, *viz.* the mention of the obſervations themſelves, as ſoon as, to facilitate the underſtanding of them, I ſhall have advertiſed you, that though I fear it will always be difficult to get out without loſs the ſelf-ſhining ſubſtance raiſed by diſtillation, yet in our experiment, becauſe the veſſels would not hold out intire to the laſt, we had more difficulty, than even we expected, to get out the luciferous matter, and were fain to ſave, as much as we could of it, by ſmall parcels, in diſtinct vials. Whereof that, which was firſt employed, though it was judged to have received the vigorouſeſt portion of the ſhining liquor; yet for a reaſon I elſewhere intimated, (and becauſe it was not at hand, when I had firſt the opportunity to uſe it) I thought fit to make my trials with the noctiluca, I had ſaved in the ſecond vial; ſetting aſide ſome more faint and aqueous liquor, that was afterwards ſaved in a third vial; and a thicker ſtuff, that remained upon the paper, when ſome of the liquor had been put into it to be filtrated. Which paper was kept in a fourth glaſs, which, though (that it might admit the paper and adhering luciferous ſtuff) it was wide-mouthed, yet was it kept carefully ſtopt. Of the phænomena I obſerved in the ſecond of theſe four glaſſes, I ſhall, God permitting, at this time, give you a ſhort account; deſigning, if my haſte will give me leave, to add ſome particulars, that I may afterwards obſerve in thoſe portions of our noctiluca, that were received in the three other glaſſes.

OBSERVATIONS

Made by Mr. BOYLE about the

AERIAL NOCTILUCA

Contained in His

SECOND VIAL.

Note, *That this vial was capable of holding, by our gueſs, about two ounces of water, but there was not in it above one ſmall ſpoonful of our liquor.*

Observation I.

THE liquor, that afforded the aerial noctiluca, (for which reaſon, and for brevity, I often call it the ſhining liquor) by day-light was not near diaphanous, and appeared muddy, and of a greyiſh colour, ſomewhat like common water, rendered opacous, by having a quantity of wood-aſhes mingled with it.

Observation II.

WHEN no light appeared in the glaſs, we obſerved all the cavity of the vial, that reached from the liquor to the neck, to be tranſparent, as if there were nothing in the glaſs, ſave a ſpoonful of dirty water at the bottom.

Observation III.

BUT when the liquor was made to ſhine vividly, then all the cavity of the glaſs, untaken up by the liquor, appeared in an external light to be full of fumes. And this ſeeming ſmoke, being, in the vial that contained it, removed into a dark place, appeared lucid, and ſometimes looked like a flame, that ſeemed to be reverberated, and to be made, as it were, to circulate by the cloſe ſtopped neck and the ſides of the vial. And the appearance of whitiſh fumes, when the glaſs was looked upon in an external light, was ſo uſual a concomitant of its fitneſs to ſhine in the dark, that by looking upon the vial by day-light, I could readily tell, by the preſence or abſence of the whitiſh miſt abovementioned, whether the matter would, in a dark place, appear luminous or not.

Observation IV.

WHEN this liquor had been kept for a competent time (as an hour or two, and ſometimes much leſs) in ſome dark and quiet place, or even in my pocket; if in a darkned room my eyes were caſt toward the place, where the vial was held, I could not perceive it to afford any light at all. And though I ſhaked the liquor ſtrongly enough, to give it at leaſt a moderate agitation, yet I could not diſcern, that this motion alone was able to bring the included liquor, or the vapours it may be ſuppoſed to have ſent up, to be manifeſtly lucid.

Observation V.

BUT as ſoon as I unſtopt the vial in the dark, there began to appear, as I expected, a light or flame in the cavity of it. I call it light or flame, becauſe I dare not yet ſpeak dogmatically of it; though it agrees with flame in divers particulars, and though alſo I am not ſure, that all flames muſt agree in all points with common flames, experience having taught me the contrary; and particularly, that ſome flames will burn, and be propagated in cloſe-ſtopt veſſels. I ſhall therefore on this account, and for brevity's ſake, allow the aggregate of our ſhining fumes the name of flame, (which *Ariſtotle* himſelf ſomewhere ſtiles *fumus accenſus)* but without poſitively aſſerting, that it deſerves it, unleſs further phænomena ſhall be found to intitle it thereunto. But whatever be the nature and ſubject of this light, the light itſelf appeared to have, in great part, a dependance on the freſh air, as I judged probable by the following phænomena.

Observation VI.

FIRST, I never obſerved the light to diſcloſe itſelf firſt, either in the liquor, or upon the ſurface of it; but ſtill the ſhining began at the upper part, which was firſt touched by the outward air, and made a progreſs, quick indeed, but not ſo inſtantaneous, as that the eye could not follow it, from the top to the bottom of the vial.

OBSERVATION VII.

SECONDLY, the contact of the air ſeemed neceſſary to the propagation as well as production of this flame or light: for if, having ſhaken the vial, that the liquor might either wet the ſtopple, or communicate ſomething to it, I warily bended the cork this way and that way, ſo that only a few particles of the outward air could inſinuate themſelves between the ſtopple and the neck of the glaſs; there would appear on the ſides, and perhaps beneath the cork, little flames, as it were; which yet, though very vivid, were not able to propagate themſelves downwards: whereas, when the cork was quite removed, and acceſs was thereby allowed to a greater quantity of air, the flame or light (as was lately noted) preſently diffuſed itſelf through the whole cavity of the vial, and reached as low as the ſurface of the liquor.

OBSERVATION VIII.

THIRDLY, Though oftentimes the light ſeemed more vivid near the ſurface of the liquor, than elſewhere; (whether becauſe the lucid matter was there more denſe, I now examine not) yet when by ſtopping the vial again, preſently after I had opened it, I endeavoured to deſtroy the flame or light; I generally obſerved, that when it was ready to vaniſh, (which in that caſe it uſually did in no long time) it began to diſappear firſt in the bottom of the vial, and ſeemed to ſhrink, as it were, more and more upwards, till it expired at the neck of the vial, (where it was neareſt to the air.)

OBSERVATION IX.

FOURTHLY, But on the other ſide, when I kept it unſtopt for ſome time, as for two or three minutes of an hour, though I afterwards ſtopt the vial very cloſe, the air, that had more leiſure than ordinary to inſinuate itſelf, would ſo cheriſh the flame, that the light would continue ſometimes an hour or two, and laſted once or twice no leſs than three hours.

OBSERVATION X.

FIFTHLY and *laſtly*, It ſeemed, that ſome elaſtical particles of the included air, or ſome ſubſtance, that concurred to the maintenance of the flame, was waſted, or depraved and weakned, by being pent up in the vial with the emanations of the liquor; ſince, when the vial had been kept ſtopt a competent time, and its cavity appeared tranſparent in the outward light, if I cautiouſly took out the ſtopple, the external air ſeemed manifeſtly to ruſh in, as if the ſpringyneſs of the internal had been notably debilitated by the operation of the flame upon the matter, with which it was kept impriſoned.

SOME of theſe phænomena eaſily brought into my mind ſome of thoſe of an odd experiment, that I formerly imparted to the curious. In which experiment I obſerved (among other things) that the ſpirit of urine, impregnated with copper, after the manner there preſcribed, would continue limpid and colourleſs, as long as the vial, that contained it, was kept cloſe ſtopt. But when once the air came to touch the ſurface of it, it would (ſometimes in leſs than a minute of an hour) be ſo affected thereby, that in a very ſhort time (for it was often within ſome minutes) the liquor would become of a tranſparent ſky-colour; and afterwards, the vial being well ſtopt, and kept in a quiet place, would by degrees grow diaphanous, and the air included with it was wont to have its ſpring weakned. And as the change of colour was firſt produced at the ſurface, where the liquor and air touched one another, and was afterwards thence propagated downwards; ſo when this cœruleous colour began to diſappear, the liquor manifeſtly became limpid firſt at and near the bottom, that is, the part, which is remoteſt from the ſuperior air.

BUT to return to our noctiluca, the five phænomena laſt recited, and ſome others, ſeem to favour the conjecture or ſuſpicion I lately propoſed, *about the intereſt of the air in our unburning flame*. And to examine that ſuſpicion, I thought it leſs proper to make the foregoing trials with a more vigorous noctiluca, than in a ſubſtance, wherein, as in that we have hitherto employed, the diſpoſition to be kindled, or excited to ſhine, was but faint; ſo that being, as long as it remained, unexcited, opacous and dark, the abſolute, or almoſt abſolute, neceſſity of the concurrence of air to the actual ſhining (that conſtantly enſued upon its contact) of the diſpoſed matter, ſeemed manifeſt enough.

AN

OCCASIONAL DIGRESSION.

BUT to what this concurrence or efficacy of the air ought to be aſcribed, is a problem, that ſeemed to me ſo difficult, that my thoughts were put upon ſeveral conjectures for ſo much as a tolerable ſolution of it; for a taſte of which, I ſhall venture to offer to you one or two of thoſe, that leaſt diſpleaſe me.

I THOUGHT it not improbable, that the admitted air, either by ſome ſubtil ſalt that it contained, or upon ſome ſuch account, excited in the fumes, it mingled with, a kind of fermentation, or (if you pleaſe) a commotion, by which means the matter acquired ſo briſk an agitation, as to propagate the motion to the eye, and there make an impreſſion, the ſenſe whereof we call light: though it ſeemed alſo not unlikely, that ſome of the particles of the ſupervening air may ſo aſſociate themſelves with thoſe congruous ones, they met with in the cavity of the vial, that, by that coalition, corpuſcles were produced, fitted to be, by the ſubtil æthereal matter, that abounds in the pores of the air, ſo pervaded and briſkly agitated, as to produce light. And it was not new to me, that the air ſhould aſſociate itſelf with inviſible exhalations, and concur with them to make new concretions; ſince I have ſeveral times prepared a volatile ſulphureous liquor, red as a ruby, which, when the vial has been kept cloſe for ſome time, ſuffers the empty cavity of the veſſel to be tranſparent; but upon the unſtopping it, and giving acceſs to the outward air, it appears preſently full of white fumes, more opacous than a miſt. And ſomething like this, though in an inferior degree, may be obſerved, when we unſtop glaſſes, that are but partly full of ſpirit of ſalt, or *aqua fortis*, provided thoſe liquors be rectified as much, and no more, than is fit. For the contact of the air will preſently make the former manifeſtly afford white fumes, and the latter ſometimes red ones, and ſometimes otherwiſe coloured. But if I durſt mention, what my love to mankind has obliged me to conceal, even from my neareſt friends, I could give an inſtance of a ſtrange power of the air to excite a vehement motion in fitly diſpoſed matter, though it be of a conſiſtence far more unlikely to be thus agitated, than the fluid ſubſtances of our phoſphorus: ſince I experimentally know a body, dry, and ſolid enough to be pulverable, that barely by the contact of the common air, will, even when it is actually cold, in very few minutes have its parts brought to ſuch a degree of agitation, that its heat is little leſs intenſe than that of ſome actually ignited bodies, and may, if I pleaſe, by the further action of the air, be brought to afford ſome light alſo.

BUT againſt this conjecture *about the cauſe of the air's concurrence to the ſhining of our noctiluca*, there came into my mind, among other things, a ſtrong objection, that may be drawn from the conſtant noctiluca formerly mentioned to have been ſhewn by Mr. *Krafft*, in which the lucidneſs was conſtant, though the vial, that contained it, was kept ſtopt. In anſwer to this, I thought it might be ſaid, that the particles of the lucid ſubſtance, being in great numbers crowded together into a little room, theſe concentrated particles may be ſuppoſed to have been brought to ſuch a ſtate, that they needed not the renewed aſſiſtance of the outward air, to continue ſhining; either becauſe their inteſtine motions were briſk enough to diſcuſs the minute parts of the matter, wherewith they were aſſociated, and ſo from time to time to generate, or extricate, and ſupply themſelves with as many ſmall aerial particles, as were neceſſary to keep the maſs they belonged to, luminous. Which conjecture may be illuſtrated by obſerving, that though our common ordinary flames are preſently extinguiſhed, unleſs they be cheriſhed with freſh air, yet I elſewhere recite an experiment of a compoſition, which is ſo fitted to generate as much air as it needs, that I have ſeveral times found, that it may be kindled, and made to flame away, even *in vacuo Boyleano*, (as they call that made by our air-pump.)

OTHER things may be alledged both for and againſt the propoſed conjecture, about the account, on which the air concurs to the light of our liquid noctiluca; but, I hope, it will not be impertinent to add, that perhaps the concurrence of the air may be conſiderable to both the phoſphorus's, the fluid and the conſiſtent, but the external air be neceſſary only to the former: becauſe in the latter, the luciferous particles may have acquired ſuch a texture, as that of rotten wood, or rather of whitings, or the liquor of glow-worms, taken out after they are dead. For in that ſtate (whatever others have written) I have kept that juice luminous for very many hours, (not to ſay ſome days;) and it is conceivable enough, that in the conſiſtent noctiluca, by reaſon of the great numerouſneſs and extreme minuteneſs of the parts, and the unctuouſneſs or viſcoſity, or, in a word, tenacity of them, the maſs they make up is much leſs diſſipable than that, wherein the ſhining vertue of rotten wood, or the juice of dead glow-worms reſides. This conjecture may be confirmed, by obſerving, as a thing very analogous to our phænomena, that I have found ſome lights in putrid bodies to be ſo faint, that they would, like that of our fluid noctiluca, (but far more quickly) diſappear, when they were totally deprived of air, as I ſeveral times found in parcels of rotten wood. And on the contrary, others had ſo vigorous or tenacious a light or flame, that, like the ſplendor of the conſtant noctiluca, it would continue (though perhaps not in its full luſtre) when the outward air was, in our pneumatick engine, diligently drawn off from it. And on this occaſion I call to mind another experiment, which ſeems yet more analogous, than any hitherto alledged, to our preſent production of flame or light. For having purpoſely kept certain fiſh in a glaſs, freed from air, till I concluded it had lain longer than was neceſſary to bring it to that degree of putrefaction, which was wont to make ſuch fiſh, at that time of the year, to ſhine, I could not perceive in the cavity of the glaſs the leaſt glimpſe of light: and preſently after I had let in the outward air, it did (according to my expectation) as it were, kindle a flame, in the proximately diſpoſed matter, or at leaſt produce in it a manifeſt light. And it may much conduce to ſhew, that the lately mentioned difference of ſhining bodies may be but gradual, if I here obſerve, that I found by trial, that in bodies of the ſelf ſame kind, as for inſtance glow-worms, or the ſame ſpecies of rotten fiſhes;

if the light were but faint, the withdrawing of the air would, after a while, make it quite diſappear; and the re-admiſſion of the air would preſently make it re-appear, as it happens in our aereal noctiluca. But in thoſe individuals, wherein the luciferous matter was more copious and vigorous, and probably more tenacious, the abſence of the external air did ſomewhat leſſen or impair, but not quite deſtroy the light; and ſo poſſibly it might happen in Mr. *Krafft*'s conſiſtent noctiluca: For though it ſhone without the renewed acceſſion of external air, yet, that it would have been more briſk and active, if it had been aſſiſted by ſuch air, I was induced to think, becauſe (if I much miſremember not) when once, to gratify my curioſity, he took it out of the vial he uſually kept it in, it did manifeſtly ſmoke and waſte by the action of the air, and produced conſiderable effects of actual heat; for this being done in the day-time, in a room we could not darken, it could not indeed be expected, that we ſhould diſcern any augmentation of light; but yet that there was one, may probably be argued from the newly mentioned things, that uſed to be its concomitants.

SUCH obſervations and reflections incline me to think, that, to ſpeak in a general way, the light of our noctiluca's depends upon a peculiar and very briſk agitation of ſome minute particles of the ſhining matter, in point of bulk, ſhape, and contexture, peculiarly fitted to impel the contiguous æther to the bottom of our eyes; and made me think it not improbable, that the contact of freſh external air might contribute to this peculiar kind of agitation in the gummous noctiluca, as an helpful thing, and in the aerial noctiluca, as an almoſt neceſſary concurrent. But whether the air concurs to this effect, as it does itſelf excite a briſk commotion in the fumid matter it invades, or whether it makes a peculiar kind of diſſipation of it, or whether the air, or ſome fine ſubſtance contained in it, operates on this occaſion as a kind of vital ſpirit, ſuch as is found neceſſary, not only to common flame, but to that which is ſuppoſed to keep animals alive; or whether the corpuſcles of the admitted air ſo combine with thoſe, that exhale from the groſſer liquor, as to become fit to be vehemently agitated by ſome æthereal pervading ſubſtance; whether or no, I ſay, the agency of the air in our phænomena be to be referred to one or more of the newly mentioned things, or to ſome other cauſe of a peculiar and very briſk agitation, which, to ſpeak in general, ſeems to have the main ſtroke in the production of light, is left to further inquiry.

BUT I forget, that my intention was to ſet down obſervations, not hypotheſes. And indeed the hiſtorical part of what I had to ſay of phoſphorus's, is far more uſeful and certain, than the conjectures I can yet make upon it. Becauſe, though I am content to let them paſs, in regard they may afford you ſome hints of further ſpeculations; yet the true ſolution of the problem, that has occaſioned this excurſion, may depend ſo much upon further experiments and obſervations, that though it is not impoſſible, that future phænomena may favour the propoſed conjectures, yet, it is not very unlikely, that I ſhall hereafter ſee cauſe to change them for ſome hypotheſes, exceedingly different from them. To return therefore now to our hiſtorical obſervations.

OBSERVATION XI.

ALTHOUGH, in the moderately ſhaken vial, when the light was quite vaniſhed, I could not make the liquor begin to ſhine; yet when by unſtopping it a little, the flame was kindled in the cavity of the glaſs, then, by ſhaking it again, though it were done more faintly than before, the light ſeemed to be manifeſtly increaſed by this agitation.

OBSERVATION XII.

IF I took a little of our liquor, when it was in its dark ſtate, and laid it upon my hand, or on the ſtopple of the vial, it would oftentimes lie there without diſcloſing any glimpſe of light; but if I rubbed it with my finger, or ſome other fit body, it would then not only ſhine, but ſhine more vividly, than at beſt it uſed to do in the vial, when the neck of it was ſtopt; and this vivid light, whilſt I continued to rub the matter it reſided in, ſeemed from time to time to flame and flaſh, and did not only invade the noſtrils with a ſtrong and offenſive ſmell, but viſibly ſent up ſtore of ſmoke, as if it had been ſome common culinary flame; and when, upon my ceaſing to rub the extravaſated liquor, it ceaſed to ſhine for a pretty while, yet when I returned to rub it again, it would again appear luminous: but by little and little the lucid vertue decayed, till it was to no purpoſe to rub any more.

OBSERVATION XIII.

THE light of our liquor, when excited, ſeemed for degree much like that, that I obſerved in ſome ſpecies of rotten wood, that were not of the moſt vivid ſort; and when ſurrounded with bodies of black colour, the reflection of its light from them was little or none. But very white bodies, that were held contiguous to it, were manifeſtly illuſtrated by it, eſpecially, if the eye, having been long kept in the dark (whereby the pupil uſes to be much opened, and conſequently capable of admitting more numerous beams) was made more ſuſceptible of the fainter impreſſions of light. Inſomuch, that, when having placed the vial by me when I went to bed, and was awake ſome time before break of day, I encloſed both the glaſs and my head between the ſheets, the light ſeemed to me to be very conſiderable, and to enlighten

lighten the compaſs of a foot or more in diameter, and probably would have diffuſed itſelf further, if it had not been bounded by the ſheets, whoſe whiteneſs made the reflection of the light from them appear very prettily. And by the help of this light, I could eaſily perceive my fingers, and a ring I wore upon one of them, though I could not diſtinguiſh the colours of a reddiſh diamond, and a couple of emeralds, that were ſet in it.

OBSERVATION XIV.

IN reference to the light within, the included flame in our vial was opacous; for both at ſome other times, and even when I made the laſt recited obſervation, I could not at all perceive my finger, when the ſhining ſubſtance was interpoſed betwixt it and my eye. But in reference to the external light, the flame or ſhining matter was diaphanous; for even in a very faint light, by which, I think, I could ſcarce have read an ordinary print, if I held our luminous vial between the window and my eye, I could very plainly ſee my finger on the further ſide of the glaſs, though, if my eye were placed between that and the light, the tranſparency would appear ſomewhat leſſened, becauſe the cavity ſeemed, as was formerly noted, filled with a kind of whitiſh miſt. And the like tranſparency and whitiſh fumes, obſervable in the ſame luminous ſteams or flame, when the vial was looked on, againſt, and from, the light, I found, if, inſtead of the day-light, I employed the light of the candle.

OBSERVATION XV.

HAVING the opportunity of a convenient place, and a fair day, I ſet the vial about noon in a window, opened towards the ſouth, and left it there expoſed to the ſun-beams for a conſiderable time, to try, whether they would, upon the account of their agitation, or ſome imaginable affinity of nature, kindle or excite the luciferous liquor, or its effluvia. But I could not perceive, that the ſun-beams had ſuch an operation, which I chiefly concluded from my not being able to perceive any whitiſh or miſt-like fumes in the cavity of the glaſs; for I durſt not rely upon my not perceiving any light in the darkeſt corner of the room, becauſe I ſuſpected, that might proceed from my eyes having been accuſtomed to the great light of the then fair day, which made it leſs ſuſceptible of impreſſions from a faint light.

OBSERVATION XVI.

ACID and alcaliſate ſpirits being reckoned by chymiſts amongſt the moſt ſubtle and operative ſubſtances, obtainable from mixt bodies by diſtillation, I thought it very well worth while to try by taſte, whether our ſhining liquor did notably abound with particles of either of thoſe kinds. I did not find, that the liquor I put upon my tongue was in the leaſt acid; nor that it was ſenſibly alcaliſate, as divers modern chymiſts call ſuch volatile ſalts and ſpirits, as are afforded by harts-horn, blood, and ſuch like ſubjects of the animal kingdom: but it ſeemed to me to have an odd empyreumatical taſte, almoſt like that of the ſpirit of crude tartar; its ſmell being alſo like that of ſome empyreumatical oil, compounded with a ſtink, ſomewhat like that of ſtale urine. I likewiſe, for further trial, let fall upon a piece of white paper ſome drops of blue ſyrup of violets, to which I put a little of our liquor, ſtirring them together with the tip of my finger; but the mixture was not thereby turned green, which it would have been by a quarter ſo much of ſpirit of harts-horn, of blood, or of ſome other ſpirit, abounding with ſalt of an urinous nature, or (as ſome love to ſpeak) with a volatile alcali. Some other trials I made, though but with very ſmall quantities of our liquor, (becauſe I had but very little of it to ſpare;) and theſe trials did, no more than the former, evince the liquor to belong manifeſtly to the tribe of acids, or that of alcalies; though perhaps this may not be the caſe of all the portions of liquor, whether more denſe, or more aqueous and dilute, that may be obtained by ſeveral degrees of fire, and ſome other varying circumſtances, from the matter, that affords noctiluca's.

OBSERVATION XVII.

SOMETIMES, when for curioſity's ſake I ſhook the vial, ſo that the whole body, even to the bottom, of the liquor, was ſpread all over the inſide of the glaſs, I could obſerve with pleaſure, that in many places divers little grains or corpuſcles, belonging to the opacous matter, that concurred to compoſe the liquor, ſtuck here and there to the inſide of the vial; and that theſe, being of a conſiſtent, not fluid nature, and therefore probably more denſe than the thinner parts of the phoſphorus, did ſhine very prettily and diſtinctly, and looked almoſt like extreamly little ſtars, or rather radiant ſparks of fire, whoſe light was briſk enough to be diſtinctly notable, notwithſtanding that of the flame, that was contiguous to them, and filled the cavity of the vial. And theſe ſhining corpuſcles uſually continued their peculiar vividneſs, as long as I thought fit to look on them. Which great vigour of theirs, together with their duration, gave me hopes, that the further proſecution of what had been brought thus far may afford us ſome, not altogether deſpicable, quantity of the conſiſtent noctiluca, which, by reaſon of its denſity, tenacity, or other peculiar diſpoſition of parts, may ſhine like the conſtant noctiluca of Mr. *Krafft* formerly mentioned.

OBSERVATION XVIII.

BEING deſirous to try, not ſo much what the air and agitation would do, towards the kindling or exciting (not the impriſoned exhalation, but) the liquor itſelf of our noctiluca, (that having been partly done already*) as what water would do to quench it; I thought fit to make the experiment, when time and many trials had much impaired its vigour. And accordingly having, in a dark place, unſtopt the vial, and wetted the tip of my finger with the included liquor, I could not perceive, that then (as when it was freſhly made) it gave any ſenſible light. Wherefore, having rubbed the moiſtened finger againſt my other hand ſomewhat briſkly, for a few moments, both the rubbed part of my hand and my finger appeared adorned, each of them, with a flame; and though upon my dipping my finger in water (that ſtood by ready for the purpoſe) the flame was, as it were, extinguiſht, ſince the light preſently vaniſhed; yet, having taken out my wet finger again, and rubbed, without having previouſly dried it upon the other hand, as I had done before, the light, as I expected it would, did quickly re-appear.

Besides the foregoing phænomena of our luciferous matter, that occurred more regularly, there was one, that happened unexpected, and may perchance, (for till I have further obſerved, I dare not ſpeak it confidently) prove referable to the paper elſewhere publiſhed, *about ſome latent qualities of the air*.

Observation XIX.

THE phænomenon was this: having one night opened the vial ſo often mentioned, to ſhew the production of light to a virtuoſo, I quickly ſtopt it again, and put it in my pocket, till I went to ſleep; and then laying it by me in the bed (as I often did) when the candles were carried out of the room, I perceived the light, whoſe laſting, I did not expect, ſhould exceed one hour, to continue ſtill vivid enough; and then ſhaking it a little, before I compoſed myſelf to ſleep, I laid it by, till I waked in the morning, and then looking upon it again, it appeared to my eyes (that then for ſeveral hours had been unaccuſtomed to the light) to ſhine more vigorouſly, than it had done at firſt. And from the time I opened it over night, till the laſt time I had occaſion to look upon it the next morning, it had continued ſhining for twelve hours; to which, whether the extraordinary warmth, that was obſerved that particular night had contributed any thing, I dare not determine, but ſhall rather add, that though this phænomenon happened very rarely, yet this was not the only time that I obſerved it: for once more it occurred to me, and that time the light continued about fifteen hours, that I took notice of, and how much longer it might have laſted, I was hindered from obſerving. But this circumſtance ſeemed conſiderable, that the long duration of our unburning flame happened after the reſt of the trials and obſervations had been made; when by them the vigour of the luciferous matter might reaſonably be expected to have been very much impaired.

Observation XX.

WHEN I had ſet down the laſt men-mentioned phænomenon, I thought I had concluded the obſervations, peculiarly belonging to the aerial noctiluca, contained in our ſecond vial, and hitherto treated of. But now I find myſelf, by philoſophical ſincerity, obliged to add another phænomenon, which did ſomewhat trouble, as well as ſurprize me, and it was this. After the foregoing obſervations had been made with our ſecond vial, one night, that I came to open it, to ſhew one of my beſt friends the production of light, I found (little to my content) that none at all appeared, though I ſhook the contained liquor, and kept the vial a pretty while unſtopt; ſo that, if he had not known me well, he might have entertained ſiniſter thoughts of me, till having taken out ſome drops of the liquor, and rubbed it upon my hand, it afforded ſo vivid a light or flame, as ſatisfied him of the poſſibility of a true noctiluca. And ſince that time, I have not found the vial to afford any light, barely upon its being unſtopt; ſo that either (in ſpight of my care) ſomebody's unſkilful curioſity has, unknown to me, ſpoiled the liquor; or, (which is more likely) ſo little a quantity, as I had at firſt, by the many and various trials I made with it, is diſpirited and become, as it were, effœte; which it was lucky it did not do, till the forecited obſer-ſervations had been made with it. But, as in one of thoſe, it has been conjectured, that one of the chief accounts, on which the air itſelf may concur to the ſhining of our noctiluca, is, as it excited a certain kind of briſk motion in the parts of it, I thought fit to try, whether, though I had found the bare ſhaking of the vial to be ineffectual, yet an actual heat, whereby the parts muſt be more vehemently and variouſly agitated, might not enable the air to do, what otherwiſe it could not perform; I therefore held our vial near the fire, till it grew conſiderably warm, and then by ſhaking it a little, and unſtopping it in a dark place, I perceived the exhalations, that poſſeſſed the cavity of the vial, to ſhine, as formerly; but their light was ſo momentany, that it ſcarce ſooner appeared, than vaniſhed; and though afterwards it ſometimes appeared, it was not vivid, nor laſted a minute of an hour, nor perhaps half ſo long; though it ſeemed, that when freſh air was then allowed acceſs to it, its duration was thereby ſomewhat lengthned. But how long our matter will retain a diſpoſition to be excited, even by theſe means, to ſhine, experience alone can determine.

* *See above*, Obſerv. xii.

ADDITIONAL OBSERVATIONS ABOUT THE AERIAL NOCTILUCA.

YOU may remember, Sir, that, to clear the way to the twenty foregoing obſervations, I formerly told you, that we received the luciferous matter, obtained by our diſtillation, in ſeveral ſmall glaſſes, as we were able to ſave it. The parcel, that was received in the ſecond vial, afforded us the phænomena hitherto recited; and now it will be fit to add to thoſe ſuch as more lately occurred, upon our conſidering the portions of luciferous matter, preſerved in the other glaſſes, and ſome alſo of the like lucid ſubſtance, prepared another way. And though theſe obſervations be not ſo numerous, as the former, and be, a few of them, near of kin to ſome of the others, yet I ſhall not ſcruple here to ſubjoin them, both becauſe moſt of them are new, and thoſe, that are not, will ſerve to confirm and elucidate ſome of the foregoing obſervations. Beſides that, it is not eaſy to know, what phænomena may, and what cannot, be uſeful, to frame or verify an hypotheſis of a ſubject new and ſingular, about which we have not as yet (that I know of) any good hypotheſes ſettled.

A small portion of liquor, (not much exceeding a ſpoonful) that was the firſt, and was judged the beſt, I ſaved, being put into a long, and ſomewhat ſlender cylindrical vial, made of white or chryſtalline glaſs, afforded us the enſuing phænomena.

Observation I.

SOON after the muddy liquor (for ſuch it appeared to the eye) was poured into the vial, it was ſo vigorouſly luminous, (probly, in great part, from the contact and inſinuation of ſo much air, as it met with in its transfuſion,) that not only it ſhone vividly, but continued to ſhine ten hours, that I took notice of, before my occaſions made me deſiſt from obſerving it.

This experiment minds me of an objection, which I ſhould have propoſed and anſwered at the beginning of the foregoing paper, if I had then remembred to do it. For, whereas it may by ſome be thought improper for me to call our luciferous matter a ſelf-ſhining ſubſtance, in regard that it is not lucid, without the concurrence or help of the air: I anſwer, that I do (and juſtly may) employ the word ſelf-ſhining, to ſignifie, that the light our matter affords, is not a light borrowed from any external lucid, as is done by the Bolonian ſtone, and the *phoſphorus Balduini*, but proceeds, as it were, from an inward principle of light. And men ſcruple not, upon ſuch an account, to reckon the flame of a candle, and a glowing coal, to be ſelf-ſhining bodies, though neither of theſe will be kindled, or continue to ſhine, without the aſſiſtance of renewed air, no not for a few minutes: whereas, the newly recited phænomenon of our noctiluca ſhews, that our prepared matter being for a very ſhort time, (perhaps but few minutes) impregnated by the air, it will continue to ſhine many hours in a well ſtopped glaſs, that hinders it from being relieved by any ſupply of freſh air.

Observation II.

WHEN I ſet down the fifth, and ſome other of the foregoing obſervations, I was not at leiſure to diſcourſe the reaſons, that induced me to try for an aerial noctiluca; and now alſo to ſave time, I ſhall forbear launching into ſpeculations upon that ſubject, and only tell you hiſtorically, that, preſuming the matter, that would ſhine in our cylindrical glaſs, would not be ſo much the liquor itſelf, as an aggregate of ſuch effluviums of it, as, affected and excited by the air, would become lucid; I thought fit to take particular notice, how the air would work upon the exhalations of this more vigorous liquor. And accordingly, having heedfully opened the vial, though I very ſoon after ſtopped it again, I obſerved a great commotion to be made in the cavity of the glaſs, unpoſſeſſed by the liquor: for the now lucid exhalations ſeemed to have a nimble and almoſt circular motion along the ſides of the glaſs, and to make, as it were, a little whirlwind, that impetuouſly carried it round; and this renewed rotation was not only manifeſt, but laſted much longer than one would have expected; ſo great a commotion did the air ſeem to have produced in the effluviums of the liquor, and perhaps in the neighbouring parts of the liquor itſelf. Upon the ceaſing of this unuſual motion, the light did not ceaſe, but perſevered, though I had not occaſion to obſerve how long it would have laſted.

Obser-

OBSERVATION III.

I WILL not determine, whether the vertiginous motion, mentioned in the newly recited obſervation, was in part produced by what happened in the enſuing phænomenon, which was, that having heedfully taken out the ſtopple of our vial in a dark place, after it had for a long time ceaſed from ſhining, I obſerved the external air to ruſh into the cavity of the glaſs with noiſe, and ſo ſwiftly, as did, I confeſs, ſurprize me: as if the preceding flame, though not ſenſibly hot, had, after the manner of culinary flames, conſiderably weakned the ſpring of the included air, and ſo diſabled it to reſiſt the whole preſſure of the external air, when, by the removal of the ſtopple, it was expoſed thereunto. But I will not, as I was ſaying, determine, whether this irruption of the air may not have contributed to the circular motion of the lucid ſteams mentioned in the foregoing obſervation; becauſe, though the affirmative ſeems a probable cauſe, yet I was kept from concluding it a neceſſary or only cauſe of the turbinous motion, by my having ſometimes, when no ſuch irruption of the air had in a long time preceded, obſerved rotations of lucid matter in the cavity of the vial: which motion therefore ſeemed to proceed from ſome other cauſe, though (to add that by the by) this cauſe, whatever it was, produced but ſuch a rotation, as was leſs general, leſs nimble, and leſs laſting.

OBSERVATION IV.

I FORGOT to tell you in its due place, (which was before the precedent obſervations) that, whilſt our liquor was yet freſh and vigorous, I dipt my finger in it, and moiſtned with it ſeveral places of my hands, and thoſe of ſome ladies, that were deſirous to be preſent at the ſpectacle. Which done, we obſerved, that the places that were touched, eſpecially if they were a little rubbed, ſhone very vividly, as if actual flames, but not of a blue colour, like that of common ſulphur, or of ſpirit of wine, were burning on them. And theſe flames were not at all uniform in their manner of burning, for they often ſeemed to tremble much, and ſometimes, as it were, to blaze out with ſudden flaſhes, that were not laſting, (which put me in mind of ſome of the *faculæ ſolares*.) And though it might ſeem ſtrange, that ſo ſmall a quantity of matter, that ſtuck to this or that part of the hand, ſhould afford ſo durable a flame; yet if that part itſelf were rubbed againſt the ſame perſon's other hand, or the ſkin or linnen of a by-ſtander, the part new touched would ſhine, as the other continued to do. And though theſe flames were remarkable for their vividneſs, yet they continued for a good while to afford the company a very pleaſing ſpectacle; and (which was remarkable) notwithſtanding the darkneſs of the room, it was manifeſt, that they emitted great ſtore of whitiſh ſmoke, which, or ſome other effluviums from the ſame matter, imbued the neighbouring air with a rank and offenſive ſmell. The colour of theſe ſeeming flames was not like the phoſphorus of Balduinus, when it is very well prepared, and has been expoſed to a vigorous light, red, almoſt like a well kindled charcoal; but yellow, like that of the middle part of the flame of a candle.

AND notwithſtanding the blazes and ſmoke, that accompanied theſe flames, we could not perceive in them any ſenſible heat (that is, any confuſed agitation of parts, exceeding that of the parts of our organs of touch) nor did they at all ſinge the fine linnen of the ladies, whereon ſome of them ſeemed to burn; ſo that if we admit, with many learned moderns, a *flamma vitalis* in the heart, this unburning and innoxious flame may ſupply us with a far better ſpecimen or illuſtration thereof, than the flame of ſpirit of wine, that is ſtill commonly employed, for an example; though I have many years ago endeavoured to rectify the error, by proving experimentally, that the flame of ſpirit of wine is very hot and devouring, inſomuch that I have melted glaſs and gold itſelf with it.

OBSERVATION V.

WHEN, with my finger dipt in the forementioned liquor, I drew ſhort lines upon linnen, there was left a ſhining track upon that part, over which my finger had newly paſſed; ſo that it is not to be denied, that one may write lucid characters upon white paper; and yet, when, having found our liquor too thick, or too faintly lucid, to be employed, like ink in an ordinary pen, I thought fit to try, whether I could draw lucid letters with a (middle-ſized) pencil, inſtead of a pen, and had, for that purpoſe, dipt it in our liquor; I was ſomewhat ſurprized to find, that the characters I had newly drawn, did not at all ſhine in the dark: but ſuſpecting, that the pencil might have retained, among the hairs it conſiſted of, the more tenacious and vigorous parts of the matter it had imbibed, and had left only the more aqueous and ſtrengthleſs parts upon the paper, I took the pencil in one hand, and with the other compreſſed and wreathed a little the bruſhy part of it, to excite the matter, that probably was lodged there. By which means, that part of the pencil was brought to look as if it were all of a light fire, and ſeemed to burn like a ſmall wax taper; but with a more blazing and pleaſant flame, which ſometimes ſhooting downwards, and playing about the hairs, that compoſed that part of the pencil, brought into my mind thoſe verſes of *Virgil.*

Ecce levis ſummo de vertice viſus Iuli
Fundere lumen apex, tactuque innoxia molli
Lambere flamma comas, &c. Æneid.

BUT this delightful flame laſted not very long in its firſt vigour, but decayed by degrees,

grees, till no more light at all was ſeen; after which, nevertheleſs, the flame would of itſelf break out, as if it came from the internal parts of the pencil, and would ſhine a pretty while, and then ſeem quite to expire; after which, our light would on a ſudden diſcloſe itſelf again, and, when it had continued a while in a tremulous motion, die again in all appearance. And it is to be noted, that though this artificial *Ignis Lambens*, if I may ſo call it, did not, that I perceived, burn, or ſinge the ſlender hairs, among which it ſeemed to flame, yet, as often as it appeared, it did manifeſtly emit, perhaps as much, if not more ſmoke, than another burning taper of that bigneſs would have done. And this viciſſitude of extinction and re-appearance of light, laſted, till I was weary of obſerving it; and then, having again with my fingers compreſſed, and ſomewhat ſtrongly twiſted the hairs of the pencil, I made them, as formerly, afford a conſiderable light, which I thought was, whilſt I was in the very act of wreathing the hairs, accompanied with a very ſenſible, but momentany heat.

OBSERVATION VI.

BUT notwithſtanding the newly recited heat, it was in vain that I tried, by compreſſing the pencil firſt, and then rubbing it upon gunpowder, well dried, and ſomewhat heated, to fire the powder. This I failed to do likewiſe, when I made the trial with circumſtances ſomewhat more likely to make it ſucceed. Which I the leſs wondered at, becauſe I remember Mr. *Kraft*, when he kindled gunpowder in my lodging, was fain to make uſe of his conſiſtent and conſtant noctiluca; and beſides, to have the gunpowder prepared, by being made ſo hot, that it was almoſt ready to take fire of itſelf. Which circumſtance, I confeſs, I was glad of, as I alſo was of my own diſappointments, and ſome alſo of his, becauſe it gave me occaſion to think, that this, otherwiſe innocent, fire would not eaſily be perverted to the prejudice of mankind, which, I have ſuppreſſed more dangerous inventions than this, to avoid contributing to.

BUT upon this occaſion I muſt not pretermit what happened to my laborant, when the diſtillation of our luciferous matter had been freſhly made; namely, that, having taken up ſome of the thicker ſubſtance with a knife to put it into a vial, and having found, that ſome of it afterwards ſtuck to the blade, he, being in ſome haſte to wipe off the adhering matter, did with his apron take ſtrong hold of the blade on both ſides, and then with his right hand drawing out the blade nimbly, ſo that it was ſtrongly compreſſed in its paſſage between the thumb and fingers of his left hand, he was much ſurprized to feel a ſmart heat; and preſently looking upon that part of the apron, where it had been produced, perceived, that it had in it two holes of ſome bigneſs, which he concluded muſt have been produced there by burning, both becauſe of the intenſe heat he had felt before, and becauſe it was a new apron; which when I had called for, and heedfully inſpected, I did, with him, impute thoſe holes to the action of the fire. Whence I judged it very probable, that the thicker and almoſt unguentous part (if ſo I may call it) of our luciferous matter had a great diſpoſition or propenſity to admit a very briſk agitation, ſince by an almoſt momentany, and not very vehement motion, it was put into an agitation, that made it capable of burning new callicoe (for of that the apron was made.)

OBSERVATION VII.

SINCE I uſually ſet down the nocturnal obſervations about our noctiluca from time to time, as I make them, whilſt they are freſh in my memory; and alſo have ſent away to a friend many of the precedent, before I wrote (or made) the ſubſequent; you will not, I hope, think it ſtrange, either, that, not having moſt of my materials at once together before me, I have not methodized them; or, that having been able to make but gradual diſcoveries of the ſubject I inquire into, the things, I write of it, ſhould now and then chance to be coincident, and my expreſſions about it ſhould ſometimes not be altogether uniform, but the latter parts ſhould agree more or leſs with the former, as new or varying phænomena happened to require.

UPON this account, I ſhall not ſcruple to ſubjoin, what has ſince occurred to me about the phænomenon, formerly mentioned in the ſixteenth obſervation; where I told you, that I could not then clearly find, either an acid or an alcaliſate ſalt to be predominant in the luciferous matter, I then made uſe of. But, having ſince employed ſome of the water, that was taken out of a receiver, after it had there been ſomewhat impregnated with that matter, I thought fit to try, whether this water, wherein probably the ſaline particles of our ſubject might be more copiouſly diſſolved, or more active, would not diſcover itſelf to contain ſomewhat of volatile alcali. And to ſatisfy myſelf of this, I dropt a little of the liquor upon ſome ſyrup of violets, that I had put upon a piece of clean paper, and found I was not miſtaken, in thinking it would change the colour of the ſyrup from blue to green; which yet it did more faintly, than the volatile alcalies, (as they call them) even when they are phlegmatic, are wont to do. This liquor likewiſe, as I remember, made ſome conflict with ſpirit of ſalt, when I firſt put them together, as I inferred from the commotion of the mixture, and the bubbles thereby produced. Nor were theſe the only ways, by which I was induced to think, that a volatile alcali, not an acid ſalt or ſpirit, was the predominant, if not the only ſalt, contained in the faintly impregnated liquor.

OBSER-

OBSERVATION VIII.

BEFORE I had ſet down many of the obſervations contained in the firſt paper, I was deſirous to try, what would happen to our luciferous matter in ſuch a vacuum, or, if you pleaſe, in ſuch highly rarified air, as is wont to be produced by our air-pump. But, in regard a glaſs was to be opened in the exhauſted receiver, which is a difficult work to do, I was fain, for want of conveniences, to deſiſt from my endeavours, and proſecute ſome other experiments, (moſt of them already recited) till at length being furniſhed, though not with accurate, yet with tolerable means of making a trial, and thinking an imperfect one, better than none at all, I took a vial, that had ſome luciferous matter in it, though but ſuch, as was not apt to ſhine long at a time; and this vial being well ſtopt, I kept till the flame or light within it expired; then, having placed the vial in a receiver on our pneumatic engine, we pumpt out the air, and then (not without ſome difficulty) pulled out the cork in a dark place, whereupon there preſently appeared ſome light in the cavity of the vial, which I the leſs wondered at, becauſe we found by certain ſigns, that by reaſon of ſome diſadvantageous circumſtances, we could not ſo well pump out the air, and hinder the ingreſs of new, as not to leave, (though but very little, yet) enough to excite a flame, that by former experience we found to need but an inconſiderable quantity of freſh air: but we obſerved, that by the commotion of the air, occaſioned by the pumping, the flame would be, as it were, ventilated, and blown up, or made to ſhine more vividly.

OBSERVATION IX.

BUT, not being ſatisfied by the foregoing experiment, I thought fit to vary it, after the following manner. There was taken a pretty large piece of paper, which, being well moiſtned, and partly beſmeared with our luciferous matter, was thruſt into a ſomewhat wide-mouthed glaſs, which, being put unſtopt into a receiver faſtened to our pneumatic pump, and with it kept in a dark place, did there ſhine, as I expected it would, by reaſon of the contact of the air yet contained in the receiver. Preſently after this, the pump was ſet at work, and we obſerved, as formerly, that the commotion made of the air about the vial did manifeſtly enough increaſe the light for a while; and that the light ſeemed to be leſſened, during the pauſes intercepted between theſe commotions, both by reaſon of the reſt, as of the abſence of the air. And I likewiſe took notice, that the flame, that ſeemed to paſs from one part of the wrinkled paper to the other, did ſometimes appear to have, as it were, a palpitation, and to afford a very unequal light; and though, when the external air was let in through the pump into the exhauſted receiver, the flame ſeemed to be quenched, yet I judge that to be only a temporary effect of the wateriſh vapours, that the air had taken along with it in its way through the pump; and therefore I cauſed the receiver to be taken off the engine, and then, the ſpectators were quickly of my opinion, obſerving, that upon the free contact of the freſh outward air, which was not like that laſt mentioned, depraved by moiſt vapours, the matter adhering to the paper was quickly ſeen to ſhine again, and that more vividly, than it had done in the receiver. But becauſe I ſuſpected, that this veſſel could not at that time, for want of ſome conveniences, be ſo well exhauſted, as on other occaſions it has often been, though, by the phænomena hitherto recited, it ſeemed to the ſpectators, that the flame was manifeſtly befriended, and the light increaſed by the air, yet, I think, the experiment deſerves to be repeated, when I ſhall be able to do it with more exactneſs.

OBSERVATION X.

BESIDES the liquors, that afforded us the foregoing experiments, we ſaved a little, (though but very little) of a ſubſtance, that was not liquid, but yet almoſt as ſoft as mud. This we obtained, by pouring ſome of our liquor, taken out of the veſſels, when the diſtillation was ended, into a glaſs funnel, lined with cap paper, to try whether it would filter. But finding, that that, which paſſed thorough, was too thin and aqueous, the filter was haſtily, and (for that reaſon) not very orderly wrapt up, and put into a glaſs, not capacious, but yet of a moderate wideneſs at the mouth; that, both the filter might be eaſily thruſt in, and the glaſs might be exactly enough ſtopt with a ſtrong cork.

AFTER other experiments (formerly recited) had been made, I took this glaſs, and carried it into a dark place; and though I could not perceive the leaſt glimpſe of light, yet preſuming, that it contained ſome of the true matter of the aerial phoſphorus, or noctiluca, and conſequently exhalations, that, having been hindered by the ſtopple to flie away, might be kindled or excited by the appulſe of the air; I opened the glaſs, and ſaw (as I expected) an immediate apparition of light. Which light did diſcloſe itſelf, ſometimes upon a leſſer, and ſometimes upon a much greater part of the very uneven ſurface of the included paper, and ſeemed to paſs for a great while (as long as I thought fit to ſtay to obſerve it) from one part of the filter, and one ſide of the glaſs, to another: I ſay, ſeemed, becauſe perhaps the phænomenon was produced by a train of eruptions of flames, newly excited in ſeveral places, rather than a bare propagation of the ſame. But whatever it was, the motion (which was pleaſant enough to behold) was ſo odd and irregular, that it did not ill reſemble the motion of fire kindled by ſparks, ſtruck into a good quantity of tinder. And this virtue of ſhining, upon the ingreſs of the air, laſted many days in the abovementioned paper.

OBSERVATION XI.

BUT there was another filter, that afforded us a pleaſing variation of this phænomenon; the matter wrapt up in the inſide of this paper, being ſomewhat more copious, or better conditioned, than that, which adhered to the other lately ſpoken of. We took then this paper, and having unfolded it, and kept it diſplayed in a dark place, we had the pleaſure to ſee a conſiderable number of flames, of differing ſizes and figures, diſcloſe themſelves at the ſame time; and though moſt of them were vivid, yet few of them continued long in the ſelf ſame place, but they ſeemed frequently to change their ſituations among themſelves, as well as their figures, and extent; or elſe new flames did inceſſantly break forth in new places, according as the exhalations, that did copiouſly and irregularly mingle with the contiguous air, did in ſeveral places happen to be in part, as it were, kindled by it; I ſay, in part, becauſe, from the flames themſelves, as well as the unſhining parts of the filter, there did manifeſtly aſcend good ſtore of ſmoke, viſible by the light afforded by the ſhining matter: and theſe flames did not keep a conſtant tenour in their way of blazing, but had their tremblings and emications, and theſe being uſually accompanied with changes of figure, and eruptions of light in ſeveral places at the ſame time, it was a very pleaſant ſight to ſee the whole area or ſurface of the diſplayed filter look as the ſky ſometimes does, eſpecially in hot countries, when the eye may perceive flaſhes of lightning break forth in ſeveral places at once: but our coruſcations, being as well more numerous, as innocent, made the filter appear almoſt as variegated as marble paper; but with this advantage, that, beſides that the appearance was almoſt perpetually changing, the yellow parts were not only coloured, but lucid, and afforded thoſe, that looked on them with me, a delightful ſpectacle, that laſted as long as we thought fit to gaze at it.

OBSERVATION XII.

HAVING ſtrongly ſuſpected, that the agitation, duly modified, of a diſpoſed matter, was at leaſt one of the chief agents in the production of light; I was not diſcouraged, by finding that ſhaking of the vial, or making the contained liquor more than lukewarm, would not produce any apparition of light: I was not, I ſay, thereby diſcouraged from trying, whether a more intenſe heat, which would communicate a briſk and various motion to a multitude of the corpuſcles of the luciferous matter, diſperſed through the liquor, would not do, what a fainter agitation was not able to perform.

I THOUGHT alſo, it deſerved to be tried, whether a conſiderable variation of phænomena would not be conſequent to our changing the figure and capacity of the glaſs; eſpecially, if all immediate commerce between the cavity of the veſſel, and the outward air, were carefully prevented.

IN order to both theſe trials, I took ſome ſpoonfuls of aqueous liquor, impregnated with ſome of the more ſoluble portion of the luciferous matter; which liquor, when it was ſettled, was tranſparent, as having but an inconſiderable quantity (which could not eaſily be ſeparated from it) of that muddy ſubſtance, formerly more than once mentioned. And this clear liquor, which, (perhaps becauſe of the abſence of that thicker ſubſtance) was, as it ought to be for my purpoſe, ſo faintly impregnated, that it would not, with ſhaking, or a mild heat, afford any light, was put into a round bolt-glaſs, whoſe globous part was capable of holding three or four times as much, and whoſe ſtem (or pipe) was proportionable in wideneſs to it, and above a foot in length. Having carefully ſtopt this veſſel with a cork and ſealing-wax, it was in the night-time ſet in ſuch a poſture, that, by the intervention of ſand, it might be heated without breaking, (as otherwiſe it would have been in danger of doing,) and when the ball was made ſo hot, that I could not well endure it in my naked hand, I ſpeedily removed the veſſel into a dark place, and having ſhaken the liquor, I perceived a light to break forth in the ball, which preſently diffuſed itſelf thorough the whole cavity of it, but as quickly diſappeared. And ſome time after, eſpecially upon ſhaking the glaſs, the light would break forth again, and ſoon after vaniſh; and theſe fulgurations or flaſhings of light continued for a while to appear now and then; but were unequal, both as to their extent, vivideneſs, and duration; and when the liquor grew cold, they ceaſed quite.

OBSERVATION XIII.

BUT whilſt it was yet conſiderably hot, I thought fit to try, whether by breaking the liquor by a ſtrong concuſſion, ſome lucid ſubſtance would not be made to paſs out of the globous into the cylindrical part, and ſo vary the phænomena. And to this purpoſe, having violently ſhaken the liquor at ſeveral times, with pauſes interpoſed, I perceived ſome conſiderable portions of the lucid matter to aſcend into the pipe; and particularly once I had the pleaſure to ſee a portion of ſhining ſubſtance, about the bigneſs of a filbert, or a ſmall almond, mount directly upwards like a flame, but not very ſwiftly, from the globous part of the glaſs, all along the pipe, till it reached the upper part of it. And at other times, ſuch flames aſcended into the pipe, but not ſo high; whence many would have confidently inferred a poſitive levity in flame; which yet I forbear to conclude, becauſe I once (at leaſt) obſerved, one of theſe portions of ſhining matter to deſcend from the higher to the lower part of the ſtem, ſtill retaining its lucidneſs all the way.

I CANNOT now ſtay to debate, whether the phænomena, appearing in this glaſs, may illuſtrate, or facilitate the explication of what happens in the production and motions of ſome of thoſe meteors, that are called fiery; ſuch as the *Ignis Lambens*, falling ſtars, frequent lightnings without thunder, in hot ſummer-nights, and that wandering flame, called *Ignis Fatuus*: And whether or no, it may be ſaid, that when ſuch bodies are generated, there happens to be a convention of particles ſo aſſociated, that they mutually agitate each other, or are fitted to be agitated by a pervading æthereal ſubſtance, and put into a motion, like that, which in the lately mentioned portions of our ſhining matter, was able to produce light?

OBSERVATION XIV.

BUT, inſtead of purſuing this enquiry, I ſhall relate to you a phænomenon, that to me, as well as thoſe I ſhewed it to, was not a little delightful. For having, by a concuſſion, fit for that purpoſe, as it were ſpread the liquor at once all over the inſide of the globe, and of part of the ſtem, it was pleaſant to behold, how the luciferous matter, dividing itſelf variouſly in its paſſage downwards, adorned the whole cavity of the glaſs with a company of ſmall lucid bodies, that both ſhined and twinkled, like ſo many little ſtars, adorning the celeſtial globe; and the pleaſantneſs of the ſpectacle was increaſed, by their having manifeſt motions, as well as true light. The ſlowneſs of their deſcent, in lines, many of them very oblique, made this pleaſant ſight laſt the longer; and having more than once reiterated the experiment, (though not ſtill with equal ſucceſs,) it afforded me ſome varied phænomena; which I ſhall now forbear to mention, both becauſe I want time to write, and am weary of writing, as I fear you may be of reading. And therefore I ſhall here conclude your trouble and my own, as ſoon as I ſhall have added the two following particulars.

OBSERVATION XV.

THE firſt whereof is this, that having in ſuch a bolt-glaſs, as has been lately deſcribed, given purpoſely and heedfully a certain kind of ſtrong ſhake to the included liquor, when it was at a due degree of heat, (which was not intenſe) I obſerved, that on one ſide of the globous part of the glaſs, and above the body of the liquor, there was generated, as it were, a great ſpark of lucid matter, about the bigneſs of a pin's head; and yet hence, (as I expected) there quickly was a flame or light diffuſed through the capacity of the globe, where it ſoon after vaniſhed. From which phænomena, and ſome others of affinity to it, whether it may be argued, that this was a true flame, which from a very ſmall beginning, was increaſed by propagation, and kindled the diſpoſed exhalations, that it found diſperſed throughout the cavity of the glaſs; or, that the motion of all light is not neceſſarily inſtantaneous, ſince the progreſs of it, even in ſo ſmall a ſpace as our glaſs comprized, was diſcernable, I have not now the leiſure to debate, but muſt haſten to the laſt of the two promiſed particulars, which is,

OBSERVATION XVI.

THAT, (not here to mention, how I have preſerved a diſtilled luciferous matter, both with and without additaments in a conſiſtent form) to try how long I could preſerve our liquor, in a capacity to exhibit ſuch pleaſing phænomena, without giving it new air from time to time, but only by keeping in the ſpirituous parts; I cauſed the ſtem to be hermetically ſealed; preſuming, that, notwithſtanding this, I could, by a certain cautious way of holding the veſſel, ſafely bring the included liquor to an heat, ſufficiently intenſe, to afford us the phænomena of light. In which ſuppoſition I was not miſtaken, ſince the laſt recited phænomenon, beſides ſome others, was made in this hermetically ſealed veſſel, in which the contained liquor does, as I this night tried, continue fit for that purpoſe.

OF THE
Way of preparing the AERIAL NOCTILUCA.

THE ſeveral phænomena of our aerial phoſphorus or noctiluca, wherewith you have hitherto been entertained, have, I doubt not, raiſed in you a preſſing curioſity to know, of what matter this ſelf-ſhining ſubſtance was made, and how that matter was prepared, to be capable of affording it.

THOUGH two or three years are now paſt, ſince I cauſed to be made, more than once, in my furnaces, a phoſphorus, not unlike that of the learned *Balduinus*, (I ſpeak thus cautiouſly, becauſe I am not ſure, what particular matter he employs, and I have brought more than one ſort of mineral bodies, to ſhine;) yet I forbore to divulge what I knew, becauſe (as I declared to ſome curious men, that preſſed me to do it,) I was willing to leave him the liberty of publiſhing his invention. But finding he has not yet thought fit to impart it to the world, there appeared the leſs cauſe to expect, that the ſecret of the noctiluca, which is a much more valuable thing, would be ſuddenly made public; and therefore, without long waiting any man's leiſure, I reſolved to impart to the curious, (and particularly, ſir, to your ſelf,) the knowledge of the matter I wrought upon, and ſome directions how to manage it. And in purſuit of that reſolution, I am willing to gratify the virtuoſi with that very proceſs (for ſubſtance) which I ſet down for my own remembrance, after I had the firſt time actually made the aerial noctiluca; and which I afterwards depoſited, ſealed up, in the hands of the very ingenious ſecretary of the Royal Society, in the preſence of divers members of that illuſtrious company. And though, ſince that time, ſome other trials have enabled me to obſerve ſome circumſtances, pertinent to that purpoſe; yet I thought fit to leave it as it was, that others finding themſelves, in ſome ſort, obliged to employ their own induſtry, their trials may, as mine have done, produce an inſtructive diverſification of effects, in an attempt, where experience invites me to think, that various degrees of fire and other circumſtances, (and perhaps caſualties too) may diverſify the phænomena, and thereby both inrich the yet wanted and deſigned hiſtory of light, and aſſiſt the ſpeculative, to accommodate a good hypotheſis to them. Reſerving then for another time my latter remarks upon the obſervations and proceſs, delivered in this paper, I ſhall now only give you a few ſhort advertiſements about it.

FIRST, I will not poſitively affirm, that the matter, I employed, is the very ſame, that was made uſe of, by the ingenious German chymiſts in their noctiluca; for ſome inquiſitive men have very lately told me, that the Germans mingle two or more diſtillable materials; whereas I employed but one matter, capable of diſtillation.

SECONDLY, though all the twenty foregoing obſervations, and moſt of the ten additional ones annexed to them, were made with that ſubſtance, which I gueſs to be at leaſt the chief, that is employed by the Germans, (which was done for a particular reaſon, not needful to be here expreſſed,) yet I firſt thought, and upon my very firſt trial, found, that it is poſſible to make a noctiluca of a dry and pulverable ſubſtance, that, for ought I can gueſs, was never employed by Mr. *Krafft*, or thoſe he had his ſecret from. And beſides this ſecond ſort of phoſphorus's, we made a third, that was obtained from a body, that never had been either a part, or an excrement, of a human body, nor was mingled with any thing, that had been ſo. But though I found theſe ſelf-ſhining ſubſtances ſomewhat differing from thoſe made of the liquor, hereafter to be named; yet, I cannot ſtay at preſent to ſay any thing more of them, being content to have intimated, that ſelf-ſhining phoſphorus's have been actually obtained from more ſingle ſubjects, than one.

THIRDLY, to name the matter, though never ſo explicitely, would not, in my opinion, have ſufficed to inform thoſe, that would work upon it. For chymiſts themſelves would, in all probability, work, (as hitherto, on other occaſions, they have wrought) upon the volatile and ſaline, which they preſume to be the only ſpirituous and noble parts of the concrete, throwing away the reſt as uſeleſs and abominable. And on this occaſion, let me add, that I was the rather induced to ſet down this proceſs, that we may both obſerve and thankfully acknowledge the wiſdom and bounty of the great author of nature, who, for our encouragement to ſtudy even his meaneſt works, has been pleaſed, in a body, that is commonly thought one of the deſpicableſt of the univerſe, to lodge ſo glorious and excellent a thing, as a ſelf-ſhining ſubſtance.

FOURTHLY, And I ſcarce doubt, but this, though it will be admired now, will be much more prized hereafter, when it ſhall be brought to greater perfection; and when men ſhall have diſcovered more of its uſes, which probably will be great in phyſic, and, perhaps I might add, to ſome purpoſes, that few chymiſts themſelves do yet dream of.

FIFTHLY, one thing remains, that, to ſave ingenious men ſome labour and charge, I think fit to give early notice of; namely, that having, for trial ſake, employed the liquor, hereafter to be named, without previous fermentation or putrefaction; though it was proceeded with after the ſame manner with that, whereby we obtained our noctiluca; and though it afforded a ſubſtance, for colour and conſiſtence, not unlike our luciferous matter; yet I could not find, that that ſubſtance would at all ſhine. And indeed, there are ſo many circumſtances, whoſe miſtake may make the experiment miſcarry, (as I have found to my trouble, even ſince the phoſphorus, whoſe phænomena are firſt ſet down, was made,) that, though I were not now in haſte, I ſhould be content to take time to learn better from experience, how to inſtruct others, before I venture to do it circumſtantially; and he, that ſhall, at the firſt attempt, ſucceed in preparing this liquor, ſhall be thought by me, either a very ſkilful, or a lucky operator.

SIXTHLY and laſtly, that it may appear, as well by the very different preparations, as by the differing phænomena of the phoſphorus hermeticus, and of the aerial noctiluca, that there is a great diſparity between thoſe lucid bodies, I ſhall here briefly add the way we employed to make either the phoſphorus Balduini, or ſome other like it, (for I am not certain, what is the very way of that learned man) as it was practiſed in my furnaces; which, in ſhort, is this.

A DISSOLUTION being made of fine white chalk in good ſpirit of nitre, or clean aqua fortis, it is to be filtrated thorough cap-paper, and the clear ſolution is to be evaporated, till there remain a dry ſubſtance: with this white calx, you are to overlay the inſide of ſome veſſel, made of good earth, that will endure the fire, and that of a round figure, which is more convenient, than that of ordinary crucibles; and to the matter contained in this veſſel, you are to give for about half an hour or an hour, (according to the largeneſs of it, and other circumſtances) a due degree of fire, which it is not eaſy to hit, and which ordinarily requires a conveniently ſhaped veſſel, whereby the flame or heat may be reverberated, till you perceive the matter to have acquired a diſpoſition, to retain the light; and then the earthen veſſel, which uſually ought to be ſomewhat ſhallow, and not to exceed many inches in diameter, is to have a cover of fine glaſs or cryſtal carefully cemented on to it, to preſerve it from its great enemy, the air.

WHAT we have obſerved, in proſecuting this preparation, is not ſo proper to be delivered at this time, when my haſte, as well as ſome other things, make it more fit, that we ſhould forthwith return to our aerial noctiluca, of which, after the foregoing things have been premiſed, it is time, that now there ſhould follow the proceſs.

THE

PROCESS.

THERE was taken a conſiderable quantity of human urine, (becauſe the liquor yields but a ſmall proportion of luciferous matter,) that had been, (a good part of it at leaſt) for a competent while, digeſted or putrified, before it was uſed. This liquor was diſtilled with a moderate heat, till the ſpirituous parts were drawn off; after which, the ſuperfluous moiſture alſo was abſtracted, (or evaporated away) till the remaining ſubſtance was brought to the conſiſtence of a ſomewhat thick ſyrup, or a thin extract. This was well incorporated with about thrice its weight of fine white ſand, and the mixture was put into a ſtrong retort; to which was joined a large receiver, in good part filled with water. Then, the two veſſels being carefully luted together, a naked fire was gradually adminiſtered for five or ſix hours, that all, that was either phlegmatic, or otherwiſe volatile, might come over firſt. When this was done, the fire was increaſed, and at length, for five or ſix hours made, (NB) which it ſhould be in this operation) as ſtrong and intenſe, as the furnace (which was not bad) was capable of giving. By this means, there came over good ſtore of white fumes, almoſt like thoſe, that appear in the diſtillation of oil of vitriol; and when thoſe fumes were paſt, and the receiver grew clear, they were after a while ſucceeded by another ſort, that ſeemed in the receiver to give a faint bluiſh light, almoſt like that of little burning matches dipt in ſulphur. And laſt of all, the fire being very vehement, there paſſed over another ſubſtance, that was judged more ponderous than the former, becauſe (NB) much of it fell through the water to the bottom of the receiver; whence being taken out, (and partly even whilſt it ſtaid there) it appeared by ſeveral effects, and other phaenomena, to be (as we expected) of a luciferous nature.

THE ways I employed to make a ſelf-ſhining ſubſtance, out of other matters than that expreſſed in this proceſs, I muſt, for certain reaſons, forbear to acquaint you with, at this time.

I MIGHT, from the foregoing proceſs, take occaſion to enquire, whether the matter, wherein the ſhining faculty chiefly reſides, do not conſiſt, not (as one would expect) of the volatile and ſpirituous parts of our animal liquor, but of its (not abſolutely, but) more fixt ſalt, and ponderous foetid oil, aſſociated in a peculiar manner and proportion. And from thence I might take a riſe, to propoſe my conjectures of the cauſe of the lucidneſs of our luciferous matter; and alſo, both to add ſomewhat to what, (two or three years ago) I wrote about the deſpiſed ſapa of urine, in reference to ſome uncommon menſtruums; and to make enquiry into other things relating to the nature of light and flame, eſpecially as found in our noctiluca; theſe things, I ſay, I might hence take occaſion to propoſe my thoughts of; but want of time, together with hopes of further diſcoveries, make me willing to defer the doing it, till I ſhall have more leiſure to frame conjectures, and perhaps more phaenomena to ground them upon. In the mean while, that, I may no further lengthen a letter too prolix already, by apologies for myſelf, or compliments to you; I ſhall at preſent only beg the favour of your candid animadverſions upon what I have written, and of thoſe ſingular obſervations I hear you have made, about the light of ſtinking fiſhes; both which, you need not doubt, will be as welcome, as, I doubt not, they will prove inſtructive to,

SIR,

Your moſt affectionate,

and moſt humble ſervant,

R. B.

A

NEW LAMP,

Contrived by the Honourable

ROBERT BOYLE, Eſq;

First printed in *Hooke's Philoſ. Collect.* Nº ii. p. 33. *An.* 1680.

ABCD is a veſſel of latton well ſodered every where. BC, EF, are two bottoms ſodered to that veſſel. FG is a pipe ſodered to the bottoms aforeſaid, and whoſe aperture is in the great cavity FA. H is a hole in the pipe FG, opening between the two bottoms BC, EF. I is another hole, to which is ſodered a pipe IG bended upwards at G. PP is a little veſſel fit to receive the wick of the lamp. LM is a ſlender pipe open at both ends, and ſodered to the cover AD in L, and to the bottom EF in M; ſo that by that pipe the external air may communicate between the two bottoms, without penetrating into the cavity AF. N is a ſhort pipe ſodered to a hole in the cover AD, ſo that thereby one may pour oil into the cavity AF; and ſtop it afterwards very cloſe with cork.

FOR the filling up of this engine, you muſt ſtop the aperture G of the pipe IG with a long pin fitted for that purpoſe, and the upper end of the pipe LM muſt be ſtopped too: then pour in your oil by the aperture N; which done, this ſame aperture N is to be ſhut up exactly, and both the others to be opened, *viz.* G and L. Then it will come to paſs, that the oil through the pipe IG will run and fill the veſſel P, until its ſuperficies be in the ſame level with the hole H and no more, as might be eaſily demonſtrated.

Now it is eaſy to ſee, that this lamp is free from all the inconveniences the lamp of *Cardan* is ſubject to; for,

1. The air doth not get into it by ſtarts, or gluts, as it doth in *Cardan*'s lamp; but when the oil in PP being waſted by the flame, comes to have its ſuperficies lower than the hole H; the oil from the cavity AF runs into PP gently, becauſe its place, left in the cavity AF, is eaſily ſupplied by the external air, which thorough the pipe LM and the hole H gets up into the ſaid cavity AF.

2. When the air contained in the cavity AF comes to be rarified by ſome heat, it drives out much oil, and ſo is able to choak *Cardan*'s lamp; but in this, the oil being ſo driven out, gets into the ſpace between the two bottoms, as well as into the veſſel PP: now the ſaid ſpace between the two bottoms, by reaſon of its largeneſs, receiving twenty or thirty times more oil than the veſſel PP, it follows, that the ſuperficies of the oil therein riſeth twenty or thirty times leſs, than if all the oil had been driven into the ſaid veſſel. Therefore, when we fill the lamp, we muſt take care, that the pipe L may be well ſhut, ſo that the air between the two bottoms, finding no iſſue, may keep the oil from filling that ſpace, which by that means, when the hole L is open, will be fit to receive the oil driven by the rarefaction of the air in the cavity AF.

3. The oil being always kept almoſt at the ſame diſtance from the flame, the wick will not be quickly conſumed.

4. You have the conveniency to put new oil into the lamp, without moving, or extinguiſhing the ſame; for you need but ſhut up G and L, and pour the oil through N, as hath been ſaid in the beginning.

Although this lamp cannot ſerve for all the uſes, that may be expected from the many contrivances publiſhed in the year 1677, by Mr. *Hooke*, yet it may be looked upon as uſeful too, becauſe it is eaſy to be made good and cheap without incumbrance, and ſo may do very well for ordinary uſe.

A DIS-

A
DISCOURSE
OF
THINGS
ABOVE
REASON.

INQUIRING

Whether a PHILOSOPHER ſhould admit there are any ſuch.

To which are annexed by the PUBLISHER (for the affinity of the ſubjects)

Some ADVICES about judging of THINGS, ſaid to tranſcend REASON.

An ADVERTISEMENT.

THE latter of the two following dialogues is but a part of a diſcourſe, conſiſting of ſome conferences, whereof that was neither the firſt nor the laſt. This it was thought fit the reader ſhould have notice of, that he may the more eaſily gueſs upon what account it is, that ſome clauſes in the firſt page, (and perhaps a few other paſſages elſewhere,) contain ſomewhat, that appears not altogether the ſame it would have done, if there had been no need to make any alteration at all in that page. But becauſe, though there was a connection between that dialogue and the reſt of the papers, from which it is diſmembered, yet its dependency upon the others is not ſo very great, but that the publiſher thought the divulging of it might be uſeful and ſeaſonable; and therefore finding, that want of leiſure, and much diffidence, made the author unwilling to reviſe, and part with the other papers, that accompanied this, which now comes forth; he prevailed with him to ſuffer that dialogue to take its fortune, which the publiſher hopes may be ſuch, as may encourage the author to communicate what he has further meditated upon ſuch ſubjects.

A DISCOURSE of THINGS above REASON.

The ſpeakers are, *Sophronius*, *Eugenius*, *Pyrocles*, and *Timotheus*.

Eugen. THE ſeriouſneſs you yet retain in your looks, and the poſture we found you in at our entrance, makes me fear theſe two gentlemen and I are unſeaſonable intruders, that are ſo unhappy as to diſturb your meditations.

Sophron. INSTEAD of doing that, you will much promote them, if you pleaſe to accompany me in them: for the ſubject, that buſied my thoughts, is both ſo abſtruſe and ſo important, that it needs more than one to conſider it, and deſerves, that he ſhould be a far better conſiderer than I, who therefore muſt think myſelf far leſs fit for that taſk than you.

Eugen. I WILL puniſh the flattery of theſe laſt words, by declining to make any return to it.

Pyroc. AND I, gentlemen, to prevent the loſs of time and words between you, ſhall, without farther ceremony, aſk *Sophronius*, what his thoughts were employed about when we came in.

Sophron. I WAS then muſing upon a ſubject, that was newly propoſed to me by our common friend *Arnobius*, who would needs have my opinion, whether, and if at all, how far, we may employ our reaſonings about things that are above our reaſon, as Chriſtians grant ſome myſteries of their religion to be.

Eugen. If, by things above reaſon, be meant only thoſe, that are undiſcoverable by reaſon without revelation; I ſhould not heſitate to ſay, that there may be divers things of that kind: for the free decrees of God, and his determinations concerning the government of the world, and the future ſtate of mankind (to name now no others) are things, which no human reaſon can pry into, but muſt owe the fundamental diſcovery it makes of them to the revelation of him, whoſe purpoſes they are.

But if, by things above reaſon, be meant ſuch, as though delivered in words free from darkneſs and ambiguity, are not to be conceived, and comprehended by our rational faculty, I ſhall freely confeſs, that I ſcarce know what to ſay upon ſo unuſual and ſublime a ſubject.

Pyroc. For my part, gentlemen, I think it were very requiſite to be ſure in the firſt place, that the ſubject of our diſcourſes is not chimerical, but that we can really know, that there are things we cannot comprehend, though they be propoſed to us in expreſſions no leſs clear than ſuch, as would ſuffice to make other things intelligible to us.

Sophron. Your cautiouſneſs, *Pyrocles*, muſt not be rejected by me, who when, before you came in, I was putting my thoughts into ſome order, judged it unfit to conſider, either how one might know what things were to be looked on as above reaſon; how far we may diſcourſe of them; or whether or no any ſupernaturally revealed propoſitions, ſuch as divines call articles of faith, ought to be reckoned among them, till I ſhould have firſt ſeriouſly enquired, whether in general we ought to admit any ſuch objects of our contemplation, as theſe, and the like queſtions ſuppoſe.

Eugen. I hope then, that this being the firſt thing you purpoſed to enquire into, we may, without too much boldneſs, deſire to know what came into your mind about it.

Sophron. If I had brought my conſiderations to an iſſue upon that ſubject, I ſhould, with leſs reluctancy, acquaint you with them; but ſince I have yet made but an imperfect progreſs in my enquiry, inſtead of delivering any poſitive opinion upon ſo abſtruſe a ſubject, I ſhall only tell you, that, as far as I could yet diſcern, it ſeemed to me, that among the objects our reaſon may contemplate, there are ſome, whoſe nature we cannot comprehend; others, whoſe attributes or actions are ſuch, as that we cannot underſtand how they ſhould belong to the ſubject, or elſe that we cannot conceive how they ſhould conſiſt with ſome acknowledged truth.

Eugen. So that, if I apprehend you right, you do not only admit ſome things to be above reaſon, but make no leſs than three ſorts of them.

Sophron. If you will needs have two of them to be coincident, I ſhall not much contend; but, I think, the number you have named may, without any great inconvenience, be admitted: for by things above reaſon, I here underſtand (not falſe or abſurd ones, but) ſuch, as though the intellect ſees ſufficient cauſe (whether on the ſcore of experience, authentic teſtimony, or mathematical demonſtration) to aſſent to; yet it finds itſelf reduced, when it is converſant about them, to be ſo with a notable and peculiar diſadvantage: and this diſadvantage does uſually proceed, either from the nature of the thing propoſed, which is ſuch, that we cannot ſufficiently comprehend it; or from our not being able to conceive the manner of its exiſting and operating; or from this, that it involves ſome notion or propoſition, that we ſee not how to reconcile with ſome other things, that we are perſwaded to be a truth. The firſt of theſe three ſorts of things may, for brevity and diſtinction ſake, be called incomprehenſible, the ſecond inexplicable, and the third unſociable. But for fear leſt the ſhortneſs I have uſed in my expreſſions may have kept them from being ſo clear, I ſhall ſomewhat more explicitely reckon up the three ſorts of things, that ſeem to me above reaſon.

The firſt conſiſts of thoſe, whoſe nature is not diſtinctly and adequately comprehenſible by us: to which ſort perhaps we may refer all thoſe intellectual beings (if it be granted that there are ſuch) as are by nature of a higher order than human ſouls. To which ſort ſome of the angels (at leaſt of the good ones) may probably belong; but more than probably we may refer to this head the divine author of nature and of our ſouls, Almighty God, whoſe perfections are ſo boundleſs, and his nature ſo very ſingular, that it is no leſs weakneſs than preſumption to imagine, that ſuch finite beings as our ſouls can frame full and adequate ideas of them. We may indeed know by the conſideration of his works, and particularly thoſe parts of them that we ourſelves are, both that he is, and in a great meaſure what he is not; but to underſtand throughly what he is, is a taſk too great for any but his own infinite intellect: and therefore, I think, we may truly call this immenſe object, in the newly declared ſenſe, *ſupra-intellectual*.

Eugen. I suppose I may now aſk, what is the ſecond ſort of things above reaſon?

Sophron. It conſiſts of ſuch, as though we cannot deny that they are, yet we cannot clearly and ſatiſfactorily conceive, how they can be ſuch as we acknowledge they are. As how matter can be infinitely, (or which is all one, in our preſent diſcourſe, indefinitely) diviſible; and how there ſhould be ſuch an incommenſurableneſs betwixt the ſide and diagonal of a ſquare, that no meaſure, how ſmall ſoever, can adequately meaſure both the one and the other.

That matter is endleſſly diviſible, is not only the aſſertion of *Ariſtotle* and the ſchools, but generally embraced by thoſe rigid reaſoners, geometricians themſelves; and may be farther confirmed by the other inſtance of the ſide and diagonal of a ſquare, whoſe incommenſurableneſs is believed upon no leſs firm a proof, a proof, than a demonſtration of *Euclid*, and was ſo known a truth among the antients, that *Plato* is ſaid to have pronounced him rather a beaſt than a man, that was a ſtranger to it. And yet if continued quantity be not diviſible without ſtop, how can we conceive but that there may be found ſome determinate part of the ſide of a ſquare, which being often enough repeated, would exactly meaſure the diagonal too. But though mathematical demonſtrations aſſure us, that theſe things are ſo, yet thoſe, that have ſtrained their brains, have not been able clearly to conceive how it ſhould be poſſible, that a line (for inſtance) of not a quarter of an inch long ſhould be ſtill diviſible into leſſer and leſſer portions, without ever coming to an end of thoſe ſub-diviſions; or how among the innumerable differing partitions into aliquot parts, that may be made of the ſide of a ſquare, not one of thoſe parts can be found exactly to meaſure ſo ſhort a line as the diagonal may be.

Eugen. THERE is yet behind, *Sophronius*, the third ſort of thoſe things, which, according to you, ſurpaſs our reaſon.

Sophr. I SHALL name that too, *Eugenius*, as ſoon as I have premiſed, that ſome of the reaſons, that moved me to refer ſome inſtances to this head, do not ſo peculiarly belong to thoſe inſtances, but that they may be applicable to others, which it was thought convenient to refer to the ſecond or firſt of the foregoing heads: and this being once intimated, I ſhall proceed to tell you, that the third ſort of things, that ſeem to ſurpaſs our reaſon, conſiſts of thoſe, to which the rules and axioms and notions, whereby we judge of the truth and falſhood of ordinary, or other things, ſeem not to agree.

THIS third ſort being ſuch as are incumbred with difficulties or objections, that cannot directly and ſatisfactorily be removed by them, that acquieſce in the received rules of ſubordinate ſciences, and do reaſon but at the common rate, ſuch objects of contemplation as this third ſort conſiſts of, having ſomething belonging to them, that ſeems not reconcilable with ſome very manifeſt, or at leaſt acknowledged truths.

THIS it may here ſuffice to make out by a couple of inſtances, the one of a moral, the other of a mathematical nature. And firſt, that man has a free will, in reference at leaſt to civil matters, is the general confeſſion of mankind: all the laws, that forbid and puniſh murder, adultery, theft, and other crimes, being founded on a ſuppoſition, that men have a power to forbear committing them; and the ſenſe men have of their being poſſeſt of this power over their own actions is great enough to make malefactors acknowledge their puniſhments to be juſt, being no leſs condemned by their own conſciences, than by their judges.

AND yet (ſome Socinians, and ſome few others excepted) the generality of mankind, whether Chriſtians, Jews, Mahometans, or Heathens, aſcribe to God an infallible preſcience of human actions, which is ſuppoſed by the belief of prophecies, and the recourſe to oracles, by one or other of which two ways the embracers of the ſeveral religions newly mentioned have endeavoured and expected to receive the informations of future things, and ſuch as depend upon the actings of men. But how a certain fore-knowledge can be had of contingent things, and ſuch as depend upon the free will of man, is that, which many great wits, that have ſolicitouſly tried, have found themſelves unable clearly to comprehend; nor is it much to be admired, that they ſhould be puzzled to conceive, how an infinitely perfect being ſhould want preſcience, or that their will ſhould want that liberty, whereof they feel in themſelves the almoſt perpetual exerciſe.

THE other inſtance I promiſed you, *Eugenius*, is afforded me by geometricians: for theſe (you know) teach the diviſibility of quantity *in infinitum*, or without ſtop, to be mathematically demonſtrable. Give me leave then to propoſe to you a ſtrait line of three foot long divided into two parts, the one double to the other. I ſuppoſe then, that according to their doctrine a line of two foot is diviſible into infinite parts, or it is not: if you ſay it is not, you contradict the demonſtrations of the geometricians; if you ſay that it is, then you muſt confeſs, either that the line of one foot is diviſible into as many parts as the line of two foot, though the one be but half the other, or elſe that the infinite parts, into which the line of one foot is granted to be diviſible, is exceeded in number by the parts, into which the line of two foot is diviſible, and conſequently that the line of two foot has a multitude of parts greater than infinite. Which reaſonings may let us ſee, that we may be reduced either to reject inferences legitimately drawn from manifeſt or granted truths, or to admit concluſions, that appear abſurd, if we will have all the common rules, whereby we judge of other things, to be applicable to infinites.

AND now, gentlemen, having acquainted you with what ſorts of things ſeem to be above reaſon, I muſt, to prevent miſtakes, deſire you to take along with you this advertiſement; that though the nobleneſs and difficulty of ſo uncultivated a ſubject inclined me to offer ſomething towards the elucidating of it, by ſorting thoſe things into three kinds; yet I ſhall not, and need not in this conference, inſiſt on them ſeverally, or lay any ſtreſs on this partition. For though I have above intimated, that a propoſition may ſpeak of ſomewhat that is ſupra-intellectual, or elſe contain ſomewhat, which we cannot conceive how it may be true; or laſtly teach us ſomewhat for a truth, that we cannot reconcile with ſome other thing, that we are convinced is true; yet if but any one of theſe have true inſtances belonging to it, that may ſuffice for my main purpoſe in this place, where I need only ſhew in general, that there may be things,

that

that ſurpaſs our reaſon, at leaſt ſo far, that they are not to be judged of by the ſame meaſures and rules, by which men are wont to judge of ordinary things; for which reaſon I ſhall often give them one common name, calling them priviledged things.

Eugen. Methinks that to manifeſt the imperfections of our reaſon, in reference to what you call priviledged things, you need not have recourſe to the unfathomable abyſſes of the divine nature, ſince for aught I know, *Pyrocles*, as well as I, may be non-plus'd by an inſtance, that came into my mind *de compoſitione continui*.

Timoth. Since *Sophronius* has not thought fit to give us any of the arguments of the contending parties, I ſhall be glad to know what difficulty occurred to you.

Eugen. Suppose a great circle divided into its three hundred and ſixty degrees; and ſuppoſe, that as great a number as you pleaſe, or can conceive, of ſtrait lines, be drawn from the ſeveral deſignable parts of ſome one of theſe degrees to the centre; it is manifeſt, that the degrees being equal, as many lines may be drawn from any, and ſo from every one of the others, as from that degree, which was pitched upon.

Then ſuppoſe a circular arch, equal to the aſſumed degree, to be further bent into the circumference of a little circle, having the ſame centre with a great one, it follows from the nature of a circle, and has been geometrically demonſtrated, that the ſemidiameters of a circle, how many ſoever they be, can no where touch one another but in the centre. Whence it is evident, that all the lines, that are drawn from the circumference to the centre of the greater circle, muſt paſs by differing points of the circumference of the ſmaller, (for elſe they would touch one another before they arrive at the centre) and conſequently, that as many lines ſoever, as can even mentally be drawn from the ſeveral points of the circumference of the great circle to the common centre of both circles, muſt all paſs through different points of the little circle, and thereby divide it into as many parts (proportionably ſmaller) as the greater circle is divided into: ſo that here the circumference of the leſſer circle preſents us with a curve line, which was not poſſibly diviſible into more parts than an arch of one degree, or the three hundred and ſixtieth part of the circumference of the greater circle, and yet, without being lengthned, becomes diviſible into as many parts as the whole circumference of the ſame greater circle. And though we ſhould ſuppoſe the circumference of the internal circle not to exceed one inch, and that of the exterior circle to exceed the circumference of the terreſtrial globe, or even of the firmament itſelf, yet ſtill the demonſtration would hold, and all the lines drawn from this vaſt circle would find diſtinct points in the leſſer, to paſs through to their common centre.

Timoth. Though I will not pretend to confirm what *Sophronius* has been proving, by adding arguments *a priori*; yet I ſhall venture to ſay, that I think it very agreeable both to the nature of God and to that of man, that what he has endeavoured to prove true ſhould be ſo; for we men miſtake and flatter human nature too much, when we think our faculties of underſtanding ſo unlimited, both in point of capacity and of extent, and ſo free and unprepoſſeſt, as many philoſophers ſeem to ſuppoſe. For, whatever our ſelf-love may incline us to imagine, we are really but created and finite beings (and that probably of none of the higheſt orders of intellectual creatures;) and we come into the world but ſuch, as it pleaſed the almighty and moſt free author of our nature to make us. And from this dependency and limitedneſs of our natures, it follows not only, that we may be (for I now diſpute not whether we are) born with certain congenit notions and impreſſions and appetites or tendencies of mind; but alſo that the means or meaſures, which are furniſhed us to employ in the ſearching or judging of truth, are but ſuch as are proportionable to God's deſigns in creating us, and therefore may probably be ſuppoſed not to be capable of reaching to all kinds, or if you pleaſe of truths, many of which may be unneceſſary for us to know here, and ſome may be reſerved, partly to make us ſenſible of the imperfections of our natures, and partly to make us aſpire to that condition, wherein our faculties ſhall be much enlarged and heightned. It ſeems not therefore unreaſonable to think, both that God has made our faculties ſo limited, that in our preſent mortal condition there ſhould be ſome objects beyond the comprehenſion of our intellects; that is, that ſome of his creatures ſhould not be able perfectly to underſtand ſome others, and yet that he has given us light enough to perceive, that we cannot attain to a clear and full knowledge of them.

Pyroc. I think, *Sophronius*, that I now underſtand what you mean by things above reaſon, or as you (not unfitly) ſtiled them, priviledged things: but I preſume you need not be told, that to explain the ſenſe of a propoſition, and to make out the truth of it, (unleſs in common notions, or things evident by their own light) are always two things, and oftentimes two very diſtant ones.

Sophr. I need not ſcruple, *Pyrocles*, to grant the truth of what you ſay, but I muſt not ſo eaſily admit your application of it; for among the examples I have been propoſing, there are ſome at leaſt, that do not only declare what I mean by things above reaſon, but are inſtances, and conſequently may be proofs, that ſuch things there are. And to thoſe I could have added others, if I had thought it unlikely, that in the progreſs of our conference, there may be occaſions offered of mentioning them more opportunely.

Pyroc. I have long thought, that the wit of man was able to lay a fine varniſh upon any thing, that it would recommend; but I have not till now found reaſon ſet a work to degrade itſelf, as if it were a noble exerciſe of its power to eſtabliſh its own impotency. And indeed it is ſtrange to me, how you would have our reaſon comprehend and reach things, that you yourſelf confeſs to be above reaſon, which is, methinks, as if we were told, that we may ſee things with our eyes, that are inviſible.

Sophr. I do not think that it is to degrade the underſtanding, to refuſe to idolize it; and it is not an injury to reaſon, to think it a limited faculty, but an injury to the author of it, to think man's underſtanding infinite like his. And if what I propoſed be well grounded, I aſſign reaſon its moſt noble and genuine exerciſe, which is to cloſe with diſcovered truths, in whoſe embraces the perfection of the intellect too much conſiſts, to ſuffer that perfective action to be juſtly diſparaging to it: and a ſincere underſtanding is to give, or refuſe its aſſent to propoſitions, according as they are or are not true, not according as we could or could not wiſh they were ſo; and methinks it were ſomewhat ſtrange, that impartiality ſhould be made a diſparagement in a judge. But, *Pyrocles*, leaving the reflection, with which you uſhered in your objection, I ſhall now conſider the argument itſelf, which being the weightieſt, that can be framed againſt the opinion you oppoſe, I ſhall beg leave to offer ſome conſiderations, wherein I ſhall endeavour to anſwer it, both by proving my opinion by experience, and by ſhewing that experience not to be diſagreeable to reaſon.

Pyroc. I shall very willingly liſten to what you have to ſay on ſuch a ſubject.

Sophr. I shall then in the firſt place alledge the experience of many perſons, and divers of them great wits, who have perplexed themſelves to reconcile, I ſay, not the grace of God, but even his preſcience to the liberty of man's will, even in bare moral actions: and I have found partly by their writings, and by diſcourſe with ſome of them, that the moſt towering and ſubtle ſort of ſpeculators, metaphyſicians, and mathematicians, perchance after much racking of their brains, confeſs themſelves quite baffled by the unconquerable difficulties they met with, not only in ſuch abſtruſe ſubjects as the nature of God, or of the human ſoul, but in the nature of what belongs in common to the moſt obvious bodies in the world, and even to the leaſt portions of them. You will eaſily gueſs, that I have my eye on that famous controverſy, whether or no a continued quantity (which every body, as having length, breadth, depth, muſt be allowed to have) be made up of indiviſibles. Of the perplexing difficulties of this controverſy I might give you divers confeſſions, or complaints made by a ſort of men too much accuſtomed to bold aſſertions and ſubtle arguments, to be much diſpoſed to make acknowledgments of that kind: but I ſhall content myſelf with the teſtimony, which one of the more famous modern ſchoolmen gives both of himſelf and other learned men, and which, if I well remember, he thus expreſſes. *Aggredimur continui compoſitionem, cujus hucuſque non ſuperata difficultas omnium doctorum male ingenia vexavit, neque ullus fuit, qui illam non pene inſuperabilem agnoſcat. Hanc plerique terminorum obſcuritate, illorumque replicatis & implicatis diſtinctionibus, & ſubdiſtinctionibus obtenebrant, ne aperte capiantur deſperantes rem poſſe alio modo tractari, neque rationis lucem ſuſtinere, ſed neceſſario confuſionis tenebris obtegendam, ne argumentorum evidentiâ detegatur.*

Ovied. contr. 17. Phyſ.

And though he had not been thus candid in his confeſſion, yet what he ſays might be eaſily concluded by him, that ſhall duly weigh, with how great, though not equal force of arguments, each of the contending parties imputes to the opinion it oppoſes great and intolerable abſurdities, as contained in it, or legitimately deducible from it.

Eugen. I have not the vanity to think, that the weakneſs of my reaſon ought to make another diffident of the ſtrength of his: but as to myſelf, what *Sophronius* has been ſaying cannot but be confirmed by ſeveral trials, wherein having exerted the ſmall abilities I had, to clear up to myſelf ſome of the difficulties about infinites, I perceived, to my trouble, that my ſpeculations ſatisfied me of nothing ſo much, as the diſproportionateneſs of thoſe abſtruſe ſubjects to my reaſon. But, *Sophronius*, may it not be well objected, that though the inſtances you have given have not been hitherto cleared by the light of reaſon; yet it is probable they may be ſo hereafter, conſidering how great progreſs is, from time to time, made in the diſcoveries of nature, in this learned age of ours?

Sophr. In anſwer to this queſtion, *Eugenius*, give me leave to tell you firſt, that you allow my paſt diſcourſe to hold good, for aught yet appears to the contrary: whence it will follow, that your objection is grounded upon a hope, or at moſt a conjecture, about which I need not therefore trouble myſelf, till ſome new diſcoveries about the things in queſtion engage me to a new conſideration of them. But in the mean while, give me leave to repreſent to you in the ſecond place, that though I am very willing to believe, as well as I both deſire and hope it, that this inquiſitive age we live in will produce diſcoveries, that will explicate divers of the more hidden myſteries of nature, yet I expect, that theſe diſcoveries will chiefly concern thoſe things, which either we are ignorant of for want of a competent hiſtory of nature, or we miſtake by reaſon of erroneous prepoſſeſſions, or for want of freedom and attention in our ſpeculations. But I have not the like expectations as to all metaphyſical difficulties, (if I may ſo call them,) wherein neither matters of fact, nor the hypotheſes of ſubordinate parts of learning, are wont much to avail. But however it be as to other abſtruſe objects, I am very apt to think, that there are ſome things relating to that infinite and moſt monadical being (if I may ſo ſpeak) that we call God, which will ſtill remain incomprehenſible even to philoſophical underſtandings. And I can ſcarce allow myſelf to hope to ſee thoſe obſtacles ſurmounted, that proceed not from any perſonal infirmity, or evitable faults, but from the limited nature of the intellect. And to theſe two conſiderations, *Eugenius*, I ſhall, in anſwer to your queſtion, add this alſo; that as mens inquiſitiveneſs may hereafter extricate ſome of thoſe grand difficulties, that have hitherto perplexed philoſophers, ſo it may poſſibly lead them to diſcover new difficulties, more capable than the firſt of baffling human underſtandings. For even among the things, wherewith we are already converſant, there are divers, which we think we know, only becauſe we never, with due attention, tried, whether we can frame ſuch ideas of them, as are clear and worthy for a rational ſeeker and lover of truth to acquieſce in. This the great intricacy, that conſidering men find, in the notions commonly received of ſpace, time, motion, *&c.* and the difficulties of framing perſpicuous and ſatisfactory apprehenſions even of ſuch obvious things, may render highly probable. We ſee alſo, that the angle of contact, the doctrine of *aſymptotes*, and that of ſurd numbers and incommenſurable lines, all which trouble not common accomptants and ſurveyors, (who, though they deal ſo much in numbers and lines, ſeldom take notice of any of them) perplex the greateſt mathematicians, and ſome of them ſo much, that they can rather demonſtrate, that ſuch affections belong to them, than they can conceive how they can do ſo. All which may render it probable, that mens growing curioſity is not more likely to find the ſolutions of ſome difficulties, than to take notice of other things, that may prove more inſuperable than they.

Tim. THIS conjecture of yours, *Sophronius*, is not a little favoured by the *rota Ariſtotelica*; for though the motion of a cart-wheel is ſo obvious, and ſeems ſo plain a thing, that the carman himſelf never looks upon it with wonder; yet after *Ariſtotle* had taken notice of the difficulty, that occurred about it, this trivial phænomenon has perplexed divers great wits, not only ſchoolmen, but mathematicians, and continues yet to do ſo; there being ſome circumſtances in the progreſſive motion and rotation of the circumference of a wheel, and its nave, or of two points aſſigned, the one in the former, and the other in the latter, that have appeared too ſubtle, and even to modern writers, ſo hard to be conceived and reconciled to ſome plain and granted truths, that ſome of them have given over the ſolution of the attending difficulties as deſperate; which perchance, *Pyrocles*, would not think ſtrange, if I had time to inſiſt on the intricacies, that are to be met with in a ſpeculation, that ſeems ſo eaſy as to be deſpicable.

Sophr. YOUR inſtance, *Timotheus*, muſt be acknowledged a very pregnant one, if you are certain, that a better account cannot be given of the *rota Ariſtotelica*, than is wont to be in the ſchools, by thoſe peripateticks, that either frankly confeſs the difficulties to be inſoluble, or leſs ingenuouſly pretend to give ſolutions of them, that ſuppoſe things not to be proved, or perhaps ſo much as underſtood (as rarefaction and condenſation ſtrictly ſo called,) or loſe the queſtion and perhaps themſelves, by running up the diſpute into that moſt obſcure and perplexing controverſy *de compoſitione continui*.

Eugen. I AM content to forbear preſſing any further at preſent an objection, much of whoſe force depends on future contingents; and I ſhall the rather diſmiſs the proof drawn from experience, that I may the ſooner put you in mind of your having promiſed us another argument to the ſame purpoſe, by manifeſting the opinion to be agreeable to reaſon.

Sophr. I UNDERSTAND your pleaſure, *Eugenius*, and ſhall endeavour to comply with it; but the difficulty and intricateneſs of the ſubject of our diſcourſe obliges me to do it by ſteps; and for fear we ſhould want time for more neceſſary things, I will not now ſtay to examine, whether all the things, that hitherto have appeared above reaſon, be impenetrable to us, becauſe of an eſſential diſability of our own underſtandings, proceeding from the imperfection and limitedneſs of their nature; or only becauſe of ſome other impediment, ſuch as may be eſpecially the condition of the ſoul in this life, or the infirmities reſulting from its ſtate of union with a groſs and mortal body.

FORBEARING then to diſcourſe how this came into my mind, and what thoughts I had upon it, I ſhall proceed in my conſiderations; and to clear the way for thoſe that are to follow, I ſhall in the firſt place obſerve to you, that whatever be thought of the faculty *in abſtracto*, yet reaſon operates according to certain notions or ideas, and certain axioms and propoſitions, by which, as by prototypes or models, and rules and meaſures, it conceives things, and makes eſtimates and judgments of them. And indeed when we ſay, that ſuch a thing is conſonant to reaſon, or repugnant to it, we uſually mean, that it is either immediately or mediately deducible from, or at leaſt conſiſtent with, or contradictory to one or other of thoſe ſtandard notions or rules.

AND this being premiſed, I conſider in the next place, that if theſe rules and notions be ſuch, as are abſtracted only from finite things, or are congruous but to them; they may prove uſeleſs or deceitful to us, when we go about to ſtretch them beyond their meaſure, and apply them to the infinite God, or to things, that involve an infiniteneſs either in multitude, magnitude, or littleneſs.

To illuſtrate and confirm this notion, give me leave to repreſent in the third place, that, in my opinion, all the things, that we naturally do know or can know, may be divided into theſe two ſorts; the one ſuch as we may know without a medium; and the other ſuch as we cannot attain to, but by the intervention of a medium, or by a diſcurſive act. To the firſt belong ſuch notions as are ſuppoſed to be connate, or, if you pleaſe, innate; ſuch as that two contradictories cannot be both together true; the whole is greater than any part of it; every (entire) number is either even or odd, &c. and alſo thoſe other truths, that are aſſented to upon their own account without needing any medium to prove them; becauſe that as ſoon as, by perſpicuous terms, or fit examples, they are clearly propoſed to the underſtanding, they diſcover themſelves to be true ſo manifeſtly by their own light, that they need not be aſſiſted by any intervening propoſition, to make the intellect acquieſce in them; of which kind are ſome of *Euclid*'s axioms, as that, if to equal things equal things be added, the totals will be equal; and that two right lines cannot include a ſpace. To the ſecond ſort of things knowable by us belong all, that we acquire the knowledge of by ratiocinations, wherein by the help of intervening propoſitions or mediums we deduce one thing from another, or conclude affirmatively or negatively one thing of another. This being ſuppoſed, and we being conſcious to ourſelves, if it were but upon the ſcore of our own infirmities and imperfections, that we are not authors of our own nature; for aught we know, it may be true, and all the experience we have hitherto had leads us to think it is true, that the meaſures ſuggeſted to us either by ſenſations, the reſults of ſenſible obſervation, or the other inſtruments of knowledge, are ſuch as fully reach but to finite things or beings, and therefore are not ſafely applicable to others. And divers of thoſe very principles, that we think very general, may be (if I may ſo ſpeak) but gradual notions of truth, and but limited and reſpective, not abſolute and univerſal.

And here give me leave, as a farther conſideration, to take notice to you, that though perfect ſyllogiſms be counted the beſt and moſt regular forms, that our ratiocinations can aſſume; yet even the laws of theſe are grounded on the doctrine of proportions: for even between things equal there may be a proportion, (namely that of equality;) upon which ground I ſuppoſe it is, that mathematical demonſtrations have been publickly propoſed of the grand ſyllogiſtical rules. And in conſequence of this, I ſhall add, that geometricians will tell you, that there is no proportion betwixt a finite line and an infinite, becauſe the former can never be ſo often taken, as to exceed the latter, which, according to *Euclid*'s definition of proportion, it ſhould be capable to do. Of which premiſes the uſe I would make is to perſuade you, that ſince the underſtanding operates but by the notions and truths it is furniſhed with, and theſe are its inſtruments, by proportion to which it takes meaſures, and makes judgments of other things; theſe inſtruments may be too diſproportionate to ſome objects to be ſecurely employed to determine divers particulars about them: ſo the eye being an inſtrument, which the underſtanding employs to eſtimate diſtances, we cannot by that ſafely take the breadth of the ocean, becauſe our ſight cannot reach far enough to diſcover, how far ſo vaſt an object extends itſelf. And not only the common inſtruments of ſurveyors, that would ſerve to meaſure the height of an houſe or a ſteeple, or even a mountain, cannot enable them to take the diſtance of the moon; but, when aſtronomers do, by ſuppoſition, take a chain, that reaches to the centre of the earth, (and therefore is by the moderns judged to be above four thouſand miles long;) even then I ſay, though by the help of this and the parallaxes, they may tolerably well meaſure the diſtance of ſome of the nearer planets, eſpecially the moon; yet with all their great induſtry, they cannot by the ſame way (or perhaps any other yet known) with any thing tolerable accurateneſs, meaſure the diſtance of the fixed ſtars; the ſemi-diameter of the earth bearing no ſenſible proportion to that of ſo vaſt a ſphere as the firmament, whoſe diſtance makes the parallaxes vaniſh, it being as to ſenſe all one, whether, at ſo great a remove, a ſtar be obſerved from the centre, or from the ſurface of the earth.

Rationem habere inter ſe quantitates dicuntur, quæ poſſunt multiplicatæ ſeſe mutuo ſuperare. Definit. v. Elem. V. Euclidis.

Eugen. In a matter ſo abſtruſe, a little illuſtration by examples may be very proper and welcome.

Sophr. It is ſcarce poſſible to find very appoſite examples, to illuſtrate things of a kind ſo abſtruſe and heteroclite, as thoſe may well be ſuppoſed, that do ſurpaſs our readers.

But yet ſome aſſiſtance may be borrowed from what we may obſerve in that other faculty of the mind, which is moſt of kin to the intellect, I mean the imagination; for when, for inſtance, I think of a triangle or a ſquare, I find in my fancy an intuitive idea (if I may ſo call it) of thoſe figures; that is a picture clear and diſtinct, as if a figure of three ſides, or four equal ſides and angles, were placed before my eyes.

But if I would fancy a myriagon, or a figure conſiſting of ten thouſand equal ſides, my imagination is overpowered with ſo great a multitude of them, and frames but a confuſed idea of a polygon with a very great many ſides: for if (to ſpeak ſuitably to what the excellent *Des Cartes* has well obſerved in the like caſe) a man ſhould endeavour to frame ideas of a myriagon or a chiliagon, they would be both ſo confuſed, that his imagination would not be able clearly to diſcriminate them, though the one has ten times as many ſides as the other. So if you would imagine an atom, of which perhaps ten thouſand would ſcarce make up the bulk of one of the light particles of duſt, that ſeem to play in the ſunbeams, when they are ſhot into a darkened place; ſo extraordinary a littleneſs, not having fallen under any of our ſenſes, cannot truly be repreſented in our imagination. So when we ſpeak of God's primity (if I may ſo call it,) omnipotence, and ſome other of his infinite attributes and perfections, we have ſome conceptions of the things we ſpeak of, but may very well diſcern them to be but inadequate ones: and though divers propoſitions relating to things above reaſon ſeem clear enough to ordinary wits, yet he, that ſhall with a competent meaſure of attention, curioſity, and ſkill, conſider and examine them, ſhall find, that either their parts are inconſiſtent with one another, or they involve contradictions to ſome acknowledged or manifeſt truths, or they are veiled over with darkneſs, and incumbered with difficulties, from whence we are not able to reſcue them. Thus when the ſide and diagonal of a ſquare are propoſed, we have clear and diſtinct ideas of each of them apart; and when they are compared, we may have a conception of their incommenſurableneſs. But yet this negative notion, if it be thoroughly conſidered, and far enough purſued, clearly contains that of a ſtrait line's being diviſible *in infinitum*; and that diviſibility is incumbred with ſo many difficulties, and is ſo hard to be reconciled to ſome confeſſed dictates of reaſon, that (as we have ſeen already) philoſophers and geometricians, that are convinced of the truth, are to this day labouring to extricate themſelves out of thoſe perplexing intricacies.

I WILL not trouble you with the puzzling, if not inſuperable difficulties, that incumber the doctrine of eternity, as it is wont to be propoſed in the ſchools of divines and philoſophers, leſt you ſhould alledge, that theſe difficulties ſpring rather from the bold aſſumptions and groundleſs ſubtleties of the ſchoolmen, than from the nature of the thing itſelf: but I will propoſe ſomewhat, that cannot be denied, which is, that ſome ſubſtance or other, whether, as I believe, God, or as the Peripateticks ſay, the world, or as the Epicureans contend, matter, never had a beginning, that is, has been for ever. But when we ſpeak of an eternity *à parte ante* (as they call it,) we do not ſpeak of a thing, whereof we have no conception at all, as will appear to a conſidering perſon; and yet this general notion we have is ſuch, that when we come attentively to examine it by the ſame ways, by which we judge of almoſt all other things, the intellect is non-plus'd: for we muſt conceive, that the time effluxed ſince *Adam* (or any other man as remote from us as he is ſaid to have been) began to live bears no more proportion to the duration of God, or of matter, than to thoſe few minutes I have employed about mentioning this inſtance. Nay, if we would be Ariſtotelians, the ſame thing may be ſaid as to thoſe men, that lived many thouſand millions of years before the time we reckon that *Adam* began to live in: for each of theſe times being finite, and meaſurable by a determinate number of years, can bear no proportion to that infinite number of years (or ſomewhat that is equivalent) which muſt be allowed to a duration, that never had a beginning. And as there are ſome things, whoſe nature and conſequences poſe our faculties, ſo there are others, whereof though we have a notion, yet the *modus operandi* is beyond our comprehenſion; I do not mean only the true and certain *modus operandi*, but even an intelligible one. As, though divers learned men, eſpecially Carteſians, and that upon a philoſophical account, aſſert, that God created the world; yet how a ſubſtance could be made out of nothing (as they, and the generality of Chriſtians confeſſedly hold) I fear we cannot conceive. And though all philoſophers, very few excepted, believe God to be the maker of the world (out of pre-exiſtent matter;) yet how he could make it but by locally moving the parts of the matter it was to conſiſt of, and how an incorporeal ſubſtance can move a body, which it may paſs through without reſiſtance, is that, which I fear will be found hardly explicable; for if it be ſaid, that the ſoul, being an immaterial ſubſtance, can nevertheleſs move the limbs of the human body rightly diſpoſed, I ſhall anſwer, that it does not appear, that the rational ſoul doth give any motion to the parts of the body, but only guide or regulate that, which ſhe finds in them already.

Timoth. MAY it not then be rationally ſaid, that by making obſervations of ſuch things, that are the proper objects of our faculties, and by making legitimate deductions from ſuch obſervations, and from our other knowledges whether innate or acquired, we may come to be certain, that ſome things are, and ſo have general and dark ideas of them, when at the ſame time we are at a loſs to conceive how they can be ſuch, or how they can operate and perform what they do, ſuppoſing the truth and ſufficiency of ſome other things we are convinced of? To be ſhort, negative apprehenſions we may have of ſome priviledged things; and poſitive, but indiſtinct, apprehenſions we may have of others; and that is enough to make us in ſome ſort underſtand our ſelves, and one another, when we ſpeak of them; though yet when we ſufficiently conſider what we ſay, we may find, that our words are not accompanied with clear, diſtinct, and ſymmetrical conceptions of thoſe abſtruſe and perplexing things we ſpeak of. And ſince, as hath been already ſhewn, we find by experience, that we are unable ſufficiently to comprehend things, that by clear and legitimate conſequences may be evinced to be, why ſhould not this cogently argue, that ſome of our conceptions may be of things, to which ſomewhat belongs, that tranſcends our reaſon, and ſurpaſſes our comprehenſion? And if I would play the logician with *Pyrocles*, I would tell him, that his objection deſtroys his opinion: for ſince he talks to us of what is incomprehenſible, that term muſt or muſt not be attended with ſome ſuitable idea: if it be not, let him conſider, whether, in his own phraſe, he ſpeaks ſenſe and not like a parrot; but if it be, let him then confeſs, that one may have ſome kind of idea of a thing incomprehenſible. But, *Pyrocles*, whether or no you think I prevaricate in this, you will not, I hope, ſuſpect me of doing it, in adding, that when natural theology had taught men, (as well philoſophers as others,) to believe God to be an infinitely perfect being, we ought not to ſay, that they had no idea of ſuch a being, becauſe they had not a clear and adequate one. And ſince *Ariſtotle* diſcourſes *ex profeſſo* and prolixly enough *de infinito*, and cites the antienter philoſophers for having done ſo before him; and ſince (beſides his commentators and followers) *Democritus*, *Epicurus*, followed by *Gaſſendus* and other late philoſophers, maintain, either that the world is boundleſs, or that ſpace (real or imaginary) is not finite in extent, or that the world conſiſts of atoms infinite in number; I hope you will not put ſuch an affront upon all theſe great perſons, as to think they ſaid they knew not what, when they diſcourſed *de infinito*, as they muſt have done, if they ſpake without ideas of the things they ſpake of, though it may be juſtly ſuppoſed, that the ſubject being infinite, the ideas they framed of it could not be comprehenſive and accurate.

Eugen. So that according to you, *Sophronius*, it may be ſaid, that by reaſon we do not properly perceive things above reaſon, but only perceive, that they are above reaſon, there being a dark and peculiar kind of impreſſion made upon the underſtanding, while it ſets itſelf to contemplate ſuch confounding objects; by which peculiarity of impreſſion, as by a diſtinct and unwonted kind of internal ſenſation, the underſtanding is brought to diſtinguiſh this ſort of things, namely, tranſcendent or priviledged ones, from others, and diſcern them to be diſproportionate to the powers, with which it uſes throughly to penetrate ſubjects, that are not impervious to it. As when the eye looks into a deep ſea, though it may pierce a little way into it, yet when it would look deeper, it diſcovers nothing but ſomewhat which is dark and indiſtinct, which affects the ſenſory ſo differingly from what other more genuine objects are wont to do, that by it we eaſily diſcern, that our ſight fails us in the way before it arrives at the bottom, and conſequently that there may be many things concealed there, that our ſight is unable to reach.

Timoth. I GUESS, gentlemen, by the ſilence you ſeem to conſpire in, after ſo long a debate, that you have now ſaid as much as at preſent you think fit to ſay for and againſt this propoſition, that there are things above our reaſon.

Sophr. I SHALL not, for my part, croſs your obſervation, *Timotheus*, but inſtead of adding any new proofs, ſhall only deſire you to look back upon thoſe I have preſented you already, and to let me remind you, that of the two arguments, by which I attempted to ſhew, that there are ſome things above reaſon, the firſt and chiefeſt was ſuggeſted by experience, and the other, which was drawn from the nature of things and of man, was brought, as it were, *ex abundanti*, to illuſtrate and confirm the former, and give occaſion to ſome hints about priviledged ſubjects. And therefore though I hope what has been diſcourſed by theſe gentlemen and me, may be able to perſuade *Pyrocles*, that the acknowledgment, that ſome things are above reaſon, may fairly comply with the dictates of it; yet whatever he thinks of the cogency of our diſcourſe, the truth of the main concluſion may be ſufficiently evinced by our firſt argument drawn from experience: for if we really find, that there are things, which our reaſon cannot comprehend, then whether the account theſe gentlemen and I have given, why our faculties are inſufficient for theſe things, be good or not; yet ſtill ſome true account or other there muſt be of that inſufficiency. And as we ſhould very thankfully receive from *Pyrocles* any better account than what we have propounded, ſo if he cannot aſſign any better, I hope he will join with us in looking upon this as very agreeable to our hypotheſis; ſince hereby ſome things muſt appear to us ſo ſublime and abſtruſe, that not only we find we are not able to comprehend them, but that we are unable to diſcern ſo much as upon what account it is, that they cannot be comprehended by us.

Eugen. I AM not averſe, *Sophronius*, from your paradox about gradual notions; and I am the more inclined to think, that ſome of the axioms and rules, that are reputed to be very general, are not to be indifferently extended to all ſubjects and caſes whatſoever; when I conſider the differing apprehenſions, that the mind may frame of the ſame object, as well according to the vigour, or (if I may ſo call it) rank of the underſtanding, as according to the differing information it is furniſhed with. For if one ſhould propoſe to a child, for inſtance, of four or five years old the demonſtration of the one hundred and ſeventeenth propoſition of *Euclid*'s tenth book, wherein he proves the ſide and diagonal of a ſquare to be incommenſurable; though poſſibly he may be able to read the words, that expreſs the theorem, and though he have eyes to ſee the ſcheme imployed for the demonſtration, yet if you ſhould ſpend a whole year about it, you would never be able to make him underſtand it, becauſe it is quite above the reach of a child's capacity. And if one ſhould ſtay till he be grown a man, yet ſuppoſing him to have never learned geometry, though he may eaſily know what you mean by two incommenſurable lines, yet all the reaſon he has attained to in his virile age would but indiſpoſe him to attain to that demonſtration; for all the experience he may have had of lines will but have ſuggeſted to him as a manifeſt and general truth, that of any two ſtrait lines we may, by meaſuring, find how many feet, inches, or other determinate meaſure, the one exceeds the other. And though one, that has been orderly inſtructed in all that long train of propoſitions, that in *Euclid*'s elements precede the one hundred and ſeventeenth of the tenth book, will be alſo able to arrive at an evidence of this truth, that thoſe two lines are incommenſurable; yet (as *Sophronius* formerly noted) how it ſhould be poſſible, that two ſhort lines being propoſed, whereof each by itſelf is eaſily meaſurable among thoſe innumerable multitudes of parts, into which each of them may be mentally divided, there ſhould not be any one capable of exactly meaſuring both, in that, which even a geometrician, that knows it is true, is not well able to conceive. But, gentlemen, that you may not accuſe my digreſſion, I ſhall urge theſe compariſons no further, my ſcope in mentioning them being to obſerve to you, that for aught we know to the contrary, ſuch a difference of intellectual abilities, as is but gradual in children and men, may be eſſential in differing ranks of intellectual beings. And ſo it may be, that ſome of thoſe axioms, that we think general, may, when we apply them to things, whereof they are not the true and proper meaſures, lead us into error, though perhaps intellects of an higher order may unriddle thoſe difficulties, that confound us men; which conjecture I ſhould confirm by ſome things, that would be readily granted me by Chriſtians, if I thought it proper to play the divine in a diſcourſe purely philoſophical.

Pyrocl. You, gentlemen, have taken the liberty to make long diſcourſes; and I ſhall not much blame you for it, becauſe it is a thing as more eaſily, ſo more ſpeedily done, to propoſe difficulties than to ſolve them: yet methinks amongſt you all, you have left one part of my objection unanſwered, not to ſay untouched.

Sophr. I SUPPOSE, *Pyrocles*, you mean what you ſaid about diſcerning inviſible things with the eye: but I purpoſely forbore to take notice of that, becauſe I foreſaw it might be more ſeaſonably done, after ſome other points had been cleared. Wherefore give me leave now to repreſent to you, as a corollary from the foregoing diſcourſes, that nothing hinders, but that we may reaſonably ſuppoſe, that the great and free author of human nature, God, ſo framed the nature of man, as to have furniſhed his intellective faculty with a light, whereby it cannot only make eſtimates of the power of a multitude of other things, but alſo judge of its own nature and power, and diſcern ſome at leaſt of the limits, beyond which it cannot ſafely exerciſe its act of particularly and peremptorily judging and defining. And now that God, who (as I ſaid) is a moſt free agent, may have given the mind of man ſuch a limited nature, accompanied with ſuch a meaſure of light, you will not, I preſume, deny: but the queſtion is, you will tell me, whether he hath done ſo? But I hope what has been formerly diſcourſed by theſe gentlemen and me has put that almoſt quite out of queſtion. However, I ſhall now invite you to obſerve with me, that the rational ſoul does not only paſs judgments about things without her, but about her ſelf, and what paſſes within her: ſhe ſearches out and contemplates her own ſpirituality and union with the body. The intellect judges, wherein its own nature conſiſts, and whether or no itſelf be a diſtinct faculty from the will. And to come yet cloſer to the point, be pleaſed to conſider, that logic and metaphyſics are the works of the human intellect, which, by framing thoſe diſciplines, manifeſts, that it does not only judge of ratiocinations, but of the very principles and laws of reaſoning, and teaches what things are neceſſary to the obtaining of an evidence and certainty, and what kind of mediums they are, from whence you muſt not expect any demonſtrative arguments concerning ſuch or ſuch a ſubject. To theſe things it is agreeable, that if we will compare the bodily eye with the underſtanding, which is the eye of the mind, we muſt allow this difference, that the intellect is as well a looking-glaſs as a ſenſory, ſince it does not only ſee other things, but itſelf too, and can diſcern its own blemiſhes or bad conformation, or whatever other infirmities it labours under. Upon which conſideration, we may juſtify the boldneſs of our excellent *Verulam*, who, when he ſets forth the four ſorts of idols (as he calls them,) that miſlead the ſtudiers of philoſophy, makes one of them to be *Idola Tribus*, by which he means thoſe notions, that, though radicated in the very nature of mankind, are yet apt to miſlead us: which may confirm what I was ſaying before, that the ſoul, when duly excited, is furniſhed with a light, that may enable her to judge even of divers of thoſe original notions, by which ſhe is wont to judge of other things. To be ſhort, the ſoul upon trial may find by an inward ſenſe, that ſome things ſurpaſs her forces, as a blind man, that were ſet to lift up a rock, would quickly find it too unweildy to be managed by him; and the utmoſt exerciſe of his ſtrength would but convince him of the inſufficiency of it to ſurmount ſo great a weight or reſiſtance; ſo that we do not pretend, that the eye of the mind ſhould ſee inviſibles, but only that it ſhall diſcern the limits of that ſphere of activity, within which nature hath bounded it, and conſequently that ſome objects are diſproportionate to it. And I remember, that *Ariſtotle* himſelf ſays, that the eye ſees both light and darkneſs; which expreſſion, though ſomewhat odd, may be defended by ſaying, that though ſince darkneſs is a privation, not a being, it cannot properly be the object of ſight, yet it may be perceived by means of the eye, by the very differing affection, which that organ reſents, when it is impreſſed on by luminous or enlightned objects, and when it is made uſeleſs to us by darkneſs.

Timoth. WHAT you have ſaid, *Sophronius*, has in great part prevented one thing, that might be ſaid to ſtrengthen *Pyrocles*'s objection; namely, that whereas when we ſee with our bodily eyes, there is beſides the outward organ an internal and rational faculty, that perceives by the help of the eye that, which is not directly the object of ſight; in the eye of the mind, the intellect, there is but one faculty to perceive and judge: for, according to your notion, it may be well anſwered, that the intellect being capable by its proper light to judge of itſelf and its own acts as well as of other things, there is no need of two principles, the one to perceive and the other to judge, ſince one is ſufficient for both thoſe purpoſes.

Pyrocl. WHEN I have time to reflect on all that I have heard alledged amongſt you, gentlemen, I ſhall conſider how far your arguments ought to obtain my aſſent: but in the mean while I muſt tell you, that they will ſcarce have all the ſucceſs I preſume you deſire, unleſs you add ſomewhat to free me from what yet ſticks with me of a ſcruple, that is much of the nature of that, which I formerly propoſed, being this; how we can juſtify our preſuming to diſcourſe at all of things tranſcending reaſon? For I cannot underſtand, how a man, that admits your opinions, can intelligible ſpeak (and to ſpeak otherwiſe miſbecomes a rational creature) of what is infinite, or any thing that ſurpaſſes our reaſon; ſince, when we diſcourſe of ſuch things, either our words are, or are not accompanied with clear and diſtinct ideas or conceptions of the things we ſpeak of: if they be not, what do we other than ſpeak nonſenſe, or (as hath been already ſaid) like parrots entertain our hearers with words, that we our ſelves do not underſtand? and if they be, then we do in effect comprehend thoſe things, which yet you would have me think to be, on ſome account or other, incomprehenſible.

Sophr. I ACKNOWLEDGE this difficulty, *Pyrocles*, to be a great one; but yet I think it not ſo great, as that it ought to interdict us all diſcourſing of things above reaſon: and this would perhaps appear probable enough, if, as your objection borrows much of what you have formerly alledged, ſo I may be allowed, as well to repeat ſome things as propoſe others, in making anſwer to it.

Timoth. I FOR my part ſhall not only give you my conſent to do ſo, but make it my requeſt, that you would do it; for when I look back upon our conference, methinks I plainly perceive, that partly the objections of *Pyrocles*, and partly ſome (I fear impertinent) interpoſitions of mine, have kept your diſcourſe from being ſo methodical as otherwiſe you would have made it; and therefore to be reminded of ſome of the chief points of your doctrine, as well as to connect them with thoſe you ſhall judge fit to ſtrengthen or illuſtrate them, may much conduce to make us both underſtand it more clearly, and remember it better.

Eugen. I AM much of your mind, *Timotheus*; but though my interpoſitions have been far more frequent and much leſs pertinent than yours, yet I am not troubled, that the method of our conference has been ſo much diſturbed; becauſe I think ſuch a free way of diſcourſing, wherein emergent thoughts, if they be conſiderable, are permitted to appear as they ariſe in the mind, is more uſeful than a nice method in a debate about an uncultivated and highly important ſubject, in which I think we ſhould aim at firſt rather to inquire than to reſolve, and to procure as many hints and conſiderations as we can, in order to our fuller information againſt our next meeting, without ſuppreſſing any that is true or uſeful, only becauſe it agrees not ſo well with a regular method, as it does with the deſign of our conference.

Sophr. WITHOUT reflecting upon either of thoſe gentlemen, that have been pleaſed to accuſe themſelves, I ſhall readily comply with the motion made by *Timotheus*, and after having propoſed ſome diſtinctions, make application of them.

AND the better to clear this matter in reference to *Pyrocles*'s objection, I ſhall firſt take the liberty to make ſome diſtinctions of the notions or conceptions of the mind, and for brevity ſake give names to thoſe I have now occaſion to employ. I conſider then, that whether the conceptions or ideas we have of things be ſimple or compounded, they may be diſtinguiſhed into ſuch as are particular or diſtinct, and ſuch as are only general, dark, and confuſed, or indiſtinct. So when a navigator to unknown countries firſt gets a ſight of land, though he may be ſatisfied that it is land, yet he has but a very dark and confuſed picture of it made in his eye, and cannot deſcry, whether or no the ſhore be rocky, or what creeks or harbours (if any) it have in it; much leſs whether the coaſt be well inhabited, and if it be, what kind of buildings it has; all which he may plainly and diſtinctly ſee upon his going aſhore. And this mention of the ſea puts me in mind to point at another diſtinction, which is, that of ſome things we have an adequate, of others but an inadequate conception; as if we ſuppoſe the navigator, I was ſpeaking of, ſhould look towards the main ſea, though he might ſee a good way diſtinctly, yet at length it would appear ſo darkly and confuſedly to him, that at the verge of the ſenſible horizon, his ſight would make him judge, that the ſea and ſky come together; and yet he would conclude, that the utmoſt part of the ſea he could deſcry, was but a part of the ocean, which may, for aught he knows, reach to a vaſt extent beyond the viſible horizon.

TO our confuſed, and often alſo to our inadequate conceptions, belong many of thoſe, that may be called negative, which we are wont to imploy, when we ſpeak of privations or negations, as blindneſs, ignorance, death, &c. We have a poſitive idea of things, that are ſquare and round, and black and white, and in ſhort of other things, whoſe ſhapes and colours make them the objects of our ſight: but when we ſay, for inſtance, that a ſpirit or an atom is inviſible, thoſe words are attended with a negative conception, which is commonly but dark and confuſed, becauſe it is indefinite, and removes or lays aſide thoſe marks, by which we are wont clearly to perceive and diſtinguiſh viſible ſubſtances. And when we ſay, that ſuch a thing is impoſſible, we have ſome kind of conception of what we ſpeak of, but it is a very obſcure and indiſtinct one at beſt, exhibiting only a general and very confuſed repreſentation of ſome ways, whereby one might think the thing likely to be effected, if it were at all performable, accompanied with a perception of the inſufficiency of thoſe ways. There is yet another difference in the notions we have of things, which though not wont to be obſerved, is too important to be here pretermitted, and it is this, that of ſome things we have a knowledge, that, for want of a fitter term, may be called primary or direct, and of ſome other things the knowledge we have is acquired but by inferring it from ſome more known or clearer truth, and ſo may be called inferred or illative knowledge. As when a geometrician defines to me an hyperbole, I quickly gain a clear and diſtinct idea of it; but when he proves to me, that this hyperbole may have ſuch a relation to a ſtrait line, which he calls aſymptote, that this line being continued ſtill comes nearer or nearer to the prolonged ſide of the hyperbole, and yet how far ſoever both be drawn, it will never come to touch it; his ſubtle demonſtrations preſent me with an inferred and illative truth, at which we arrived not but by the help of a train of ratiocinations, and on which if we exerciſe our imagination, we ſhall find this factitious truth, if we may ſo call it, accompanied but with a very dim and confuſed idea. To the foregoing diſtinctions give me leave to add but this one more, which belongs chiefly to the notions we have of true or falſe propoſitions; namely, that of our conceptions of things, ſome are ſymmetrical (if I may ſo call them) or every way conſiſtent, by which I mean thoſe that have theſe two qualifications, the one, that all the parts are conſiſtent among themſelves, and the other, that the entire idea is conſiſtent with all other truths; and ſome are chimerical or aſymmetrical, by which I underſtand thoſe, that are either ſelf-deſtroying by the contrariety of the parts themſelves they are made up of, as if one ſhould talk of a triangular ſquare, or a ſun-ſhiny night; or being extravagant, lead to ſome manifeſt abſurdity, that may be legitimately inferred from them, or into inextricable difficulties, or involve a real repugnancy to ſome acknowledged truth, or rule of reaſon.

To what I have hitherto ſaid I muſt add theſe two obſervations: the firſt, that the mind of man is ſo framed, that when ſhe is duly inſtructed and is not wanting to herſelf, ſhe can perceive a want of light in herſelf for ſome purpoſes, or of clearneſs and completeneſs in the beſt ideas ſhe is able to frame of ſome things, and on this account can ſo far take notice of the extent and imperfection of her own faculties, as to diſcern, that ſome objects are diſproportionate to her; as when we attentively conſider the dimenſions of ſpace, or (if the Carteſians judge aright, that body is nothing but extended ſubſtance) thoſe of the univerſe, we may by trial perceive, that we cannot conceive them ſo great, but that they may be yet greater, or, if you pleaſe, may exceed the bounds, how remote ſoever, which our former conception preſumed to aſſign them; which may be illuſtrated by what happens to the eye, when it looks upon the main ſea, ſince we eaſily grow ſenſible, that how far ſoever we can diſcover it, yet our ſight falls far ſhort of the extent of that vaſt object. And it is by the ſenſe, which the mind has of her own limitedneſs and imperfection on certain occaſions, that I think we may eſtimate what things ought not, and what ought to be looked upon as things above reaſon; for by that term, I would not have you think I mean ſuch things, as our rational faculty cannot at all reach to, or has not any kind of perception of; for of ſuch things we cannot in particular either ſpeak or think like men; but my meaning is this, that whereas the rational ſoul is conſcious to her own acts, and feels, that ſhe knows divers ſorts of things truly and clearly, and thereby juſtly concludes them to be within the compaſs of her faculties; when ſhe contemplates ſome few things, that ſeem to be of another order, ſhe is convinced, that however ſhe ſtrain her power, ſhe has no ſuch ideas or perception of them, as ſhe has or may have of thoſe objects, that are not diſproportionate to her faculties: and this is my firſt obſervation.

THE other thing that I was to obſerve about the nature of the mind is, that it is ſo conſtituted, that its faculty of drawing conſequences from known truths is of greater extent than its power of framing clear and diſtinct ideas of things; ſo that by ſubtle or ſucceſſive inferences, it may attain to a clear conviction, that ſome things are, of whoſe nature and properties (or at leaſt of ſome of them) it can frame no clear and ſatisfactory conceptions. And that men ſhould be better able to infer propoſitions about divers things, than to penetrate their nature, needs the leſs be wondered at, both becauſe it is oftentimes ſufficient for our uſes to know that ſuch things are, though that knowledge be not accompanied with a clear and diſtinct idea; and becauſe oftentimes the rules (ſuch as, whatever is produced muſt have a cauſe; and, from truth nothing rightly follows but truth) are clear and eaſy, that enable the mind to infer concluſions about things, whoſe nature is very dark and abſtruſe.

Eugen. I KNOW, *Sophronius*, that you have not laid down theſe preliminary diſtinctions and remarks, without deſigning to make uſe of them, which the little time, that now remains to manage our conference in, calls upon you to proceed to do.

Sophr. I was juſt going to ſay, *Eugenius*, that, after what I have premiſed, I hope it may be ſeaſonable to apply the newly delivered notions to the three ſorts of things, that I formerly repreſented as being in ſome ſenſe above reaſon. For I conſider, that there are ſome objects of ſo immenſe and peculiar a nature, that (if I may ſo ſpeak) by an eaſy view of the mind, that is without any ſubtle and laborious diſquiſition, the ſoul diſcerns, and, as it were, feels the object to be diſproportionate to her powers; and accordingly if ſhe thinks fit to try, ſhe quickly finds herſelf unable to frame conceptions of them fit to be acquieſced in; and this ſort of objects I do upon that account call inconceivable, or (on ſome occaſions) ſupra-intellectual.

BUT which by attentively conſidering the attributes and operations of things, we ſometimes find, that a thing hath ſome property belonging to it, or doth perform ſomewhat, which by reflecting on the beings and ways of working that we know already, we cannot diſcern to be reducible to them or derivable from them, we then conclude this property or this operation to be inexplicable; that is, ſuch, as that it cannot ſo much as in a general way be intelligibly accounted for; and this makes the ſecond ſort of our things above reaſon. But this is not all, for the rational ſoul, that is already furniſhed with innate, or at leaſt primitive ideas and rules of true and falſe, when ſhe comes to examine certain things, and make ſucceſſive inferences about them, ſhe finds (ſometimes to her wonder as well as trouble) that ſhe cannot avoid admitting ſome conſequences as true and good, which ſhe is not able to reconcile to ſome other manifeſt truth or acknowledged propoſition. And whereas other truths are ſo harmonious, that there is no diſagreement between any two of them, the heteroclite truths I ſpeak of appear not ſymmetrical with the reſt of the body of truths, and we ſee not how we can at once embrace theſe and the reſt, without admitting that grand abſurdity, which ſubverts the very foundation of our reaſonings, that contradictories may both be true. As in the controverſy about the endleſs diviſibility of a ſtrait line, ſince it is manifeſt, that a line of three foot, for inſtance, is thrice as long as a line of one foot, ſo that the ſhorter line is but the third part of the longer, it would follow, that a part of a line may contain as many parts as a whole, ſince each of them is diviſible into infinite parts; which ſeems repugnant to common ſenſe, and to contradict one of thoſe common notions in *Euclid*, whereon geometry itſelf is built. Upon which account I have ventured to call this third ſort of things above reaſon aſymmetrical or unſociable, of which eminent inſtances are afforded us by thoſe controverſies (ſuch as that of the *compoſitio continui*) wherein which ſide ſoever of the queſtion you take, you will be unable directly and truly to anſwer the objections, that may be urged to ſhew, that you contradict ſome primitive or ſome other acknowledged truth.

THESE, *Eugenius*, are ſome of the conſiderations, by which I have been induced to diſtinguiſh the things, that to me ſeem to overmatch our reaſon, into three kinds. For of thoſe things I have ſtiled unconceivable, our ideas are but ſuch, as a moderate attention ſuffices to make the mind ſenſible, that ſhe wants either light or extent enough to have a clear and full comprehenſion of them: and thoſe things, that I have called inexplicable, are thoſe, which we cannot perceive to depend upon the ideas we are furniſhed with, and to reſemble in their manner of working any of the agents, whoſe nature we are acquainted with: and laſtly, thoſe things, which I have named unſociable, are ſuch as have notions belonging to them, or have concluſions deducible from them, that are (for aught we can diſcern) either incongruous to our primitive ideas, or, when they are driven home, inconſiſtent with the manifeſt rules we are furniſhed with, to judge of true and falſe.

Eugen. I PRESUME, *Sophronius*, that by ſorting things above reaſon into three kinds, you do not intend to deny, but that it is poſſible one object may in differing regards be referred to more than one of theſe ſorts.

Sophr. YOU apprehend me very right, *Eugenius*, and the truth of what you ſay may ſufficiently appear in that nobleſt of objects, God.

Timoth. WE owe ſo much to God, the moſt perfect of beings, not only for other bleſſings, but for thoſe very intellects, that enable us to contemplate him, that I ſhall be very glad to learn any thing, that may increaſe my wonder and veneration for an object, to whom I can never pay enough of either.

Sophr. YOU ſpeak like yourſelf, *Timotheus*, and I wiſh I were as able, as I ought to be willing, to ſatisfy your deſire: but ſince we are now diſcourſing like philoſophers, not divines, I ſhall proceed to ſpeak of that glorioufeſt of objects, but as his nature or ſome of his attributes afford me inſtances to the purpoſe, for which I preſumed to mention him. When God therefore made the world out of nothing, or (if *Pyrocles* will not admit the creation) when he diſcerns the ſecreteſt thoughts and intentions of the mind, when he unites an immaterial ſpirit to a human body, and maintains, perhaps for very many years, that unparallel'd union with all the wonderful conditions he has annexed to it; when, I ſay, he doth theſe and many other things, that I muſt not now ſtay to mention, he ſupplies us with inſtances of things that are inexplicable: for ſuch operations are not reducible to any of the ways of working known to us; ſince our own minds can but modify themſelves by divers manners of thinking; and as for things without us, all that one body can do to another by acting on it, is to communicate local motion to it, and thereby produce in it the natural conſequences of ſuch motion; in all which there is no action like any of thoſe I juſt now aſcribed to God. And if we conſider, that the preſcience of thoſe future events, that we call contingent, being a perfection, is not to be denied to God, who is by all acknowledged the perfecteſt of beings; and that yet the greateſt wits, that have laboured to reconcile this infallible precognition with the liberty of man's will, have been reduced to maintain ſomething or other, that thwarts ſome acknowledged truth or dictate of reaſon: if we duly conſider this, I ſay, it will afford us an inſtance of truths, whoſe conſiſtency and whoſe ſymmetry with the body of other truths our reaſon cannot diſcern, and which therefore

fore ought to be referred to that ſort of things above reaſon, that I call unſociable. And now I come to the third ſort of theſe things, which is that I formerly mentioned, firſt under the name of incomprehenſible or ſupra-intellectual; which title, whether or no it belongs to any other object, (which I will not now enquire) doth certainly belong to God, whoſe nature, comprehending all perfections in their utmoſt poſſible degrees, is not like to be comprehenſible by our minds, who altogether want divers of thoſe perfections, and have but moderate meaſures, (not to call them ſhadows) of the reſt. We are indeed born with, or at leaſt have a power and divers occaſions to frame an idea of a being infinitely perfect, and by this idea we may ſufficiently diſcriminate the original of it, God, from all other objects whatſoever. But then, when we come to conſider attentively and minutely, what is contained in the notion of omnipotence, omniſcience, eternity, and thoſe other divine attributes, that are all united in that great confluence and abyſs of perfections, God; we may be ſure to find, that our faculties are exceedingly ſurmounted by the vaſtneſs and glorioùſneſs of that unlimited and unparallel'd object; about which, as we can diſcover that it exiſts, and that it poſſeſſes all the perfection we can conceive, ſo we may at the ſame time diſcern, that it muſt have degrees of perfection, which, becauſe of the inferiority of our nature, we are not able to conceive.

And yet this diſcovery of God's incomprehenſibleneſs may be made without ſubtle diſquiſitions, and without trains of conſequences, though not without due attention, by a direct view of the mind (if I may ſo term it,) who finds herſelf upon trial as unable fully to meaſure the divine perfections as the dimenſions of ſpace, which we can conceive to be greater and greater, without ever being able to determine any extent, beyond whoſe limits they cannot reach.

Pyroc. I suspected, *Sophronius*, by the tenour of your diſcourſe, that the laſt queſtions theſe gentlemen aſked you diverted you from ſaying ſomewhat more than you did by way of application of your preceding diſcourſe.

Sophr. I was then indeed about to make, as I now ſhall, this uſe of what I had been ſaying; that I readily acknowledge, that it is an arrogance to talk of infinite or of priviledged things with the ſame confidence, or to pretend to do it with the ſame clearneſs, wherewith knowing men may ſpeak of things unqueſtionably within the compaſs of our intellect; but that this need not hinder us from ſpeaking, nor doth diſable us from ſpeaking rationally of priviledged things themſelves. For all the notions, that are allowable, are not of the ſame ſort or order; and if none were to be admitted, but thoſe that enable us to comprehend the object, that is, which give us a clear and diſtinct knowledge of all that it contains or that belongs to it, I muſt confeſs, that we have no good notions of priviledged things in particular: but then I muſt add, that I fear we have few or none even of many things, that we think ourſelves very knowing in. And when we ſpeak of things as being above reaſon, though we have no clear, diſtinct, and adequate notion of them, yet we may have a general confuſed and inadequate notion of them, which may ſuffice to make us diſcriminate their reſpective objects from all elſe, and from one another; as may be obſerved in ſeveral ideas, that are negatively framed, ſuch as thoſe we have of inviſible, incomprehenſible, and in others, which I formerly called inferred; becauſe they accompany the remote inferences, whereby one truth is concluded from another: as when geometricians infer from ſome propoſitions in *Euclid*, that any ſtrait line may be divided farther and farther without ſtop. For of this, and ſome other propoſitions about priviledged things, we are not quite deſtitute of allowable notions; as may appear by ſome of the admirably ingenious ſpeculations of mathematicians about the affections of ſurd numbers, and about incommenſurable magnitudes; about ſome of which we have no ſuch clear and ſymmetrical conceptions, as we have of many other things, that are of a nearer and more intelligible order. And on this occaſion I ſhall not ſcruple to acknowledge, that partly by my own experience, and partly by the confeſſions of others, and by their unſucceſsful attempts, I am induced to think, that God, who is a moſt free agent, having been pleaſed to make intelligent beings, may perhaps have made them of differing ranks or orders, whereof men may not be of the principal; and that whether there be ſuch orders or no, he hath at leaſt made us men of a limited nature (in general) and of a bounded capacity. Congruouſly to this I think alſo, that he hath furniſhed man either with certain innate ideas or models and principles, or with a faculty or power and diſpoſition eaſily to frame them, as it meets with occaſions (which readily occur) to excite them: but becauſe that (as I lately noted) God intended the mind of man but of a limited capacity, his underſtanding is ſo conſtituted, that the inbred or eaſily acquired ideas and primitive axioms, wherewith it is furniſhed, and by relation or analogy whereunto it judges of all other notions and propoſitions, do not extend to all knowable objects whatſoever, but reach only to ſuch, as have a ſufficient affinity, or bear ſome proportion to thoſe primary ideas and rules of truth, which are ſufficient, if duly improved, to help us to the attainment, though not of the perfect knowledge of truths of the higheſt orders, yet to the competent knowledge of as much truth, as God thought fit to allow our minds in their preſent (and perchance lapſed) condition, or ſtate of union with their mortal bodies.

Eugen. Your opinion, *Sophronius*, if I apprehend it aright, contains two very differing aſſertions; one, that it is allowable to contemplate, and even to diſcourſe of things above reaſon, ſince we may have ſome conceptions of them, though they be but very dim and imperfect: and the other, that we ought not to look upon, or ſpeak of ſuch objects, as things that we comprehend, or have even ſuch a meaſure of knowledge of, as we have of things that are not priviledged. For of theſe we are not to ſpeak but with a peculiar warineſs, and modeſt diffidence.

Sophr. You have expreſſed my thoughts, *Eugenius*, ſince I intend not to injoin ſilence, or diſſuade curioſity, but yet forbid preſumption, in reference to priviledged things.

Timoth. And truly, *Sophronius*, I ſee no reaſon to repine at the limits, which your late diſcourſe hath, in imitation of the author of nature himſelf, aſſigned to human knowledge. For the number of priviledged things is altogether inconſiderable, in compariſon of the multitude of other things, to which our knowledge may be improved to reach, and which it far more concerns us to know well, than it doth to reſolve puzzling queſtions about things incomprehenſible; there being within the compaſs of thoſe truths enough to employ and reward our curioſity, without ſtraining and tiring our reaſon about objects that tranſcend it. And yet even about theſe ſome diſquiſitions may be allowed us; for an object, that on the account of ſome of its properties may be a priviledged one, may have divers other things belonging to it, that do not ſurpaſs our reaſon, and whoſe knowledge may therefore be attained, by the due employment of it.

Thus we uſefully ſtudy the nature of bodies, which make up the object of the excellent ſcience of natural philoſophy; though the true notion of body in general be a thing ſo difficult to frame, that the beſt of our modern philoſophers can by no means agree about it. Which I do not wonder at; becauſe if we purſue the notion of a body to the uttermoſt, it will lead us to the perplexing controverſy *de compoſitione continui*, and there you will not deny, but that the underſtanding will be left in the dark. Thus ſurveyors, carpenters, architects, and many others, know divers affections of the ſquare figure, that are of great uſe to them in their reſpective employments, though that property of the ſquare, that its ſide and diagonal are incommenſurable, be unknown to moſt of them; and if they were told of it, and would proſecute the ſpeculation, would involve them in exceeding great, and probably inſuperable, difficulties.

Sophr. To confirm what you have been telling us, *Timotheus*, I ſhall venture to add, that even about priviledged things, our inquiries, if modeſtly and diſcreetly managed, may not only be allowable, but ſometimes profitable. For even of ſuch ſubjects a ſtudious ſearch may bring us to know more than we did, though not ſo much as we would, nor enough to be acquieſced in. So that ſuch enquiries may probably teach us to know the objects better, and ourſelves better too; by giving us ſuch a ſenſible diſcovery of the inſufficiency of our underſtandings to comprehend all ſorts of things, as may be very uſeful, though not pleaſing, and may richly recompence us for the pains, that ended in ſo inſtructive a diſappointment. And let me add to the pertinent inſtances, that have been mentioned, the nobleſt that can be given; I mean the contemplation of God himſelf. For he hath ſo ordered all things, that it is ſcarce poſſible for us to be deſtitute of an idea of him, which will at leaſt repreſent him as an exiſtent being, and more perfect than any other being; and yet when we come with ſufficient application of mind to pry into the wonderful attributes of this moſt ſingular and adorable being, we are, as was lately obſerved, ſure to find ourſelves unable to comprehend ſo unbounded an object. Which yet ought not to diſcourage us from ſo noble a ſtudy, ſince we are allowed the great contentment and honour to make further and further diſcoveries of the excellenteſt of objects, by that very immenſity of his perfections, that makes it impoſſible for us to reach to the bounds of his excellency, or rather to diſcover, that it has any bounds at all.

But, gentlemen, I perceive I have been ſo tranſported by the mention of this vaſt and divine ſubject, in whoſe contemplation it is ſo eaſy and ſo pleaſant to loſe ones ſelf, that I have forgot the notice *Eugenius* gave me a pretty while ſince, that the time allotted for our preſent conference was then near expiring. And therefore I ſhall leave you to pick out of the excurſions, to which your interpoſitions tempted (not to ſay obliged) me, the applications, that I intended to make more methodically, of the diſtinctions I laid down. And I am the leſs troubled to be hindred from propoſing to you my thoughts about the way of diſtinguiſhing priviledged things from others, becauſe we have a domeſtick monitor, or a kind of an internal criterium, always at hand to help us. For I think it may well be ſaid, that the wiſe author of nature has endued the underſtanding with ſuch a quick, though internal, ſenſation, (if I may ſo call it,) that when due attention is not wanting, it can feelingly diſcern between other objects, and thoſe that are diſproportionate to its ability. As even in beaſts, the eye is ſo framed (according to the inſtitution of nature,) that if it be obverted to the bright noon-day-ſun, there needs no monitor, but the operation of the ſame ſun, to make it wink, (and perhaps water,) and thereby diſcover itſelf to be dazled and overpowered by the diſproportionate object.

Pyroc. I confeſs your diſcourſes, gentlemen, have made an unexpected impreſſion upon me; but whether that will amount to a conviction, will ſcarce appear till our next conference. Only thus much I ſhall tell you now, that it would much facilitate our agreement in opinion, if you did not contend for altogether ſo much; but would be pleaſed to leave it undetermined, whether man's intellectual faculty itſelf is uncapable, by the help of any degree of light, to diſcover and know thoſe things, which you call above reaſon: and would content yourſelves to ſay, that there are ſome things belonging to theſe ſubjects, which we muſt confeſs we have leſs clear and diſtinct notions of, than we have even of the difficulteſt of thoſe things, that are acknowledged not to ſurpaſs our reaſon: and that if we will take upon us, to determine poſitively and particularly about theſe tranſcendent things, we muſt employ ways of reaſoning congruous to their peculiar natures.

Sophr. I SHALL readily conſent not to expect your final reſolution, before our next meeting, having no cauſe to fear, that time will be unfriendly to her daughter truth.

Timoth. AND in the mean while, *Pyrocles*, I am glad to find, by the laſt part of what you juſt now ſaid, that you ſeem to be no longer indiſpoſed to admit ſome things, that (at leaſt in our preſent ſtate) do ſome way or other ſurpaſs our reaſon. For I think, that inſtead of exalting that faculty, we injure and defraud it, if we do not freely allow it as much enjoyment of truth as we are able to procure it; and conſequently if geometry, or revelation, or experience, aſſure us of divers things, of which we can know but that they are, and what they do; not, what they are, and how they act, we muſt neither refuſe, nor neglect the ſtudy of ſuch truths, any more than we would refuſe to look into any other objects than thoſe that we can look through; and therefore to enrich the intellect as much as we are able, we muſt entertain, not only thoſe truths, that we can comprehend, but thoſe alſo, how ſublime ſoever, that we can have any certain, though but a very imperfect knowledge of, eſpecially ſince thoſe remote and abſtruſe ſubjects may be as much more noble as more dark than others, and thereby render an imperfect diſcovery of them more deſirable, than a far clearer one of inferior things.

ADVICES

In JUDGING of

THINGS

Said to TRANSCEND

REASON.

The ſpeakers *Arnobius*, *Eugenius*, *Pyrocles*, and *Timotheus*.

Arnob. I WAS very glad, gentlemen, to learn this morning of *Sophronius* ſome things, whence it was eaſy to conclude, that by the diſcourſe you had with him laſt night, he has made it allowable for me to demand, and rational for you to grant, nay to proffer me a diſpenſation of the taſk you impoſed on me at our laſt meeting. For though he ſpake with the modeſty that became him of your conference, and gave me but a haſty and imperfect account of what paſſed between you; yet I think I may preſume, that by his diſcourſe, *Pyrocles* himſelf was at leaſt inclined, and you two, gentlemen, fully perſwaded to admit, that there are things above reaſon; which was the main point, about which you expected, at our laſt congreſs, that I ſhould entertain you, at our then next, or now preſent meeting.

Eugen. I deny not, that *Sophronius*'s conſiderations were prevalent on *Timotheus* and me, and have, I hope, made a good impreſſion on *Pyrocles* himſelf; but that ought not to hinder us from coming, as we now do, to claim your promiſe of entertaining us about things above reaſon. And if you will needs be diſpenſed with from repeating thoſe conſiderations, that *Sophronius* has employed already, (though I doubt not, but by repeating them, you would both ſtrengthen and advance them;) we will not be rigid exactors of our right: but yet we muſt not remit your taſk, though we are content to change it. For I queſtion not but theſe gentlemen will conſent with me, to diſcharge you of your promiſe of diſcourſing of the arguments, that may infer ſome things to be above reaſon, if you will pleaſe to afford us your thoughts, about the ways of avoiding to be impoſed on by our ſelves or others, when ſuch ſublime ſubjects are treated or diſcourſed of.

Arnob. THOUGH in the recital of your conference, *Sophronius* did but touch on ſeveral ſubjects, whereon it would be proper for me to inſiſt, in the diſcourſe you ſeem to expect from me; yet I am apt to fear, that he has ſo prevented me in what I ſhould ſay, that he has left little or nothing for me to do, but to make repetitions of what you have heard already much better expreſſed: which will be an employment far enough from being grateful, either to you or me.

Eugen. Your modeſty, ſir, is not like to defeat our curioſity; and that you may not think yourſelf hardly uſed, or condemned to bear repetition, be pleaſed to take notice, both that what we deſire as a favour, we might claim as a compenſation, and that the things we expect from you now, are not arguments to make out, that there are things above reaſon, but that you would afford us ſome "rules and directions, how to regulate the ratiocinations we make, and eſtimate thoſe we meet with, about ſuch tranſcendent ſubjects."

Arnob. I hope, *Eugenius*, you do not in earneſt think me ſo vain as to pretend to frame a logic about things above logic; or magiſterially to deliver rules about things, that are as anomalous, as they are either remote or abſtruſe. Beſides that all you have ſaid does not exempt me from a fear, that by reaſon of *Sophronius*'s omitting divers points of his diſcourſe, and my imperfect remembrance of thoſe he tranſiently and ſummarily mentioned, he has anticipated much of what were otherwiſe proper for me to ſay. But yet becauſe it is poſſible, that his thoughts and mine may have led us to have made ſome reflections, that are not at all the ſame; and that even when others happen to be coincident, it may be not altogether uſeleſs, that I ſhould endeavour to enlarge ſome things, that he has but hinted, and illuſtrate or vindicate ſome others, that will not be prejudiced by being cleared, or confirmed; and above all this, becauſe I would ſhew you, that I am willing to comply with you ſomewhat to the hazard of my diſcretion, I ſhall not refuſe to offer you ſome, not rules, but advices; provided you freely interrupt me, when I begin to trouble you with the repetition of any thing, that you have, though I have not, heard before; and provided too, that you look not on theſe advices ſo much as directions to find the truth, in ſuch abſtruſe matters, as cautions that may chance to aſſiſt you to avoid ſome errors and miſtakes.

Eugen. We are not ſo ſcrupulous, but that we ſhall upon your own terms gladly receive your thoughts, whatever names you pleaſe to give them.

Arnob. I shall then, without further preamble, comply with your commands, and propoſe as my

Firſt Advice.

That about privileged ſubjects themſelves, we do not admit any (affirmative) aſſertion, without ſuch proofs, to evince it, as are ſufficient in their kind.

I hope gentlemen, that *Sophronius* has ſo far declared to you, what is to be meant by priviledged things, that though it be a new term, yet I need not ſolicitouſly explain it; and may think it ſufficient to intimate in few words, that they are things of a very heteroclite and abſtruſe nature, and have belonging to them ſuch peculiar affections and attributes, as require, that in judging and reaſoning of them, we ſhould employ notions and rules congruous to their particular condition; ſome of them ſuperadded to, & others perhaps differing from thoſe, that men generally and ſafely enough make uſe of about common and familiar things, that are of a nature leſs impervious to our underſtandings. And if the ſhortneſs of this ſummary deſcription ſhould leave it leſs clear than I hope you find it, I foreſee there will divers occaſions of illuſtrating it, by inſtances and other ways, occur in the ſequel of our diſcourſe: in order to which I ſhall, after this ſhort and neceſſary digreſſion, return to the lately given firſt advice; and tell you, that it is grounded upon this conſideration, that it is not reaſonable to give aſſent to any thing as a truth, but upon a ſufficient reaſon of that aſſent. And though we may well grant in the general, that a thing, which ſurpaſſes our reaſon, may have belonging to it ſome affection, that is alſo above reaſon; yet we are not in particular to believe, that this or that affection doth belong to it, without particular and competent proof. For ſince about a priviledged thing, as well as about any other, propoſitions may be framed, and often are ſo, that are contrary to one another; to aſſent to both were to be ſure to believe one falſity, if not two. And if we will aſſent but to one, we muſt either judge at adventures, or allow our ſelves to examine the mediums of probation, employed on both ſides, and thereupon judge, why one of the propoſitions is to be aſſented to, and the other rejected.

Pyrocl. I am glad, *Arnobius*, that you allow yourſelf and us this manly freedom, without which our underſtandings were liable to be impoſed on in matters of the higheſt concernment: for there ſcarce ever did, or I fear ever will, want ſome men, who either out of ignorance and paſſive deluſion, or out of ſelf-confidence, or out of deſign, take upon them, with great boldneſs, to affirm what they pleaſe about priviledged ſubjects; and when they are oppoſed in their extravagancies by ratiocinations they cannot anſwer, they urge, that theſe things being above reaſon, are not to be judged of by it. But of ſuch men as theſe I uſually demand, whether their own aſſent to the things they would have us believe, be grounded upon ſome rational argument, or not? If they ſay, it is not, they are fools to believe it themſelves; and I ſhould add to the number of fools, if after this acknowledgment I ſhould believe them: but if they ſay they do, I deſire them to produce their argument; for ſince it is framed by a human underſtanding, the force of it may be alſo comprehended and judged of by a human underſtanding: and it is to no purpoſe to ſay, that the ſubject ſurpaſſes human reaſon ; for if it do ſo indeed, it will ſurpaſs theirs as well as mine, and ſo leave us upon even terms. And let the thing aſſented to be what it will, the aſſent itſelf ought to be founded upon a ſufficient reaſon, and conſequently upon one, that is intelligible to the human intellect, that is wrought on by it.

Eugen. I WILLINGLY allow, that there is a great difference between the being able and obliged to know the nature or cauſe of a thing, and the being able to give an intelligible account of the motives, that induce our aſſent to it ; and without ſuch motives, the aſſent may by chance be given to what is a truth, but that will not hinder it from being an irrational aſſent.

Timoth. I WAS not ill pleaſed, *Arnobius*, with the caution you employed in the cloſe of your advice, where, by ſaying, that the poſitive proofs you require to evince an aſſertion about a priviledged thing, muſt be ſufficient in their kind, you plainly intimate, that you do not exact rigid demonſtrations of ſuch aſſertions. And indeed it were not reaſonable you ſhould ; for ſince it is manifeſt, that there are many truths, ſuch as hiſtorical and political ones, that, by the nature of the things, are not capable of mathematical or metaphyſical demonſtrations, and yet, being really truths, have a juſt title to our aſſent ; it muſt be acknowledged, that a rational aſſent may be founded upon proofs, that reach not to rigid demonſtrations, it being ſufficient, that they are ſtrong enough to deſerve a wiſe man's acquieſcence in them. And therefore if any things can be made out to be revealed by God, concerning his own nature, or actions, or decrees, we ought firmly to believe them, becauſe that, of ſome of thoſe things, as his præſcience, mercy, *&c.* we can have no better proofs ; and of others, as what he did before our world was made, and what he will do with us after we are dead, we can can have no other conſiderable proofs at all. And the objection made by *Pyrocles* againſt the aſſenting to audacious propoſitions framed by impoſing men, will not reach our caſe : for there is no reaſon to think, that becauſe an object ſurpaſſes an human underſtanding, it muſt therefore ſurpaſs the divine intellect itſelf. And even in things, that are tranſacted in the mind of man himſelf, I may learn from another, that is not my ſuperior, what I can by no means attain to know, unleſs he be pleaſed to diſcover it to me ; as that he was at ſuch a time thinking of the creation of the world, or reſolving how to diſpoſe of his ſon, and what recompence he deſigns to give a ſervant, that he has not yet entertained.

Pyrocl. ABOUT things of ſuch a kind as you now mention, *Timotheus*, I ſhall not diſſent from you ; becauſe theſe are things, that though not diſcoverable by our reaſon till we be informed of them, are yet clearly knowable by our reaſon, when we are informed of them. But that there ſhould be things, which though perſpicuouſly propoſed, ſhould not be comprehenſible by our underſtanding, is ſuch an affront to that noble faculty, that I confeſs it has much indiſpoſed me to grant (what I am yet unwilling peremptorily to deny,) that there are, as *Sophronius* would have us think, not only ſome priviledged things, but more than one kind of them ; which if we do admit, it will place ſuch narrow limits to our underſtandings, that we muſt deſpair of the deſireableſt knowledge of all, namely that, which is converſant about the nobleſt and ſublimeſt objects.

Eugen. LEAVING to *Sophronius* the management of a point he has ſtudied, and which I have not now time ſolemnly to argue ; I ſhall only tell you in general, that I ſee no neceſſity, that intelligibility to a human underſtanding ſhould be neceſſary to the truth or exiſtence of a thing, any more than that viſibility to a human eye ſhould be neceſſary to the exiſtence of an atom, or of a corpuſcle of air, or of the effluviums of a loadſtone, or the fragrant exhalations of ambergreece, and muſk from a perfumed glove. I might here obſerve, that even by the ſame ſenſe, ſome creatures may diſcern things, that may not be perceptible to others : as no attention or application of the organ (or the noſe) will enable a man to perceive the effluvia expiring from the ſtale footſteps of a hunted and unſeen hare or deer, though hounds, and eſpecially blood-hounds, will have a vivid preception of ſuch odours, and by their help trace and purſue the flying and unſeen beaſt. This, I ſay, may be obſerved in favour of my preſent argument ; but it will perhaps be a more proper illuſtration to repreſent, that the natural incapacity of a child's intellect, to underſtand the abſtruſe affections of parabola's, hyperbola's, and the incommenſurable lines of a ſquare, hinders not thoſe figures from being contained in *rerum naturâ*, or their affections from being true and demonſtrable. And though we do admit ſome priviledged things in the ſenſe above declared, yet, (to ſay ſomewhat to obviate *Pyrocles*'s fear) there is no neceſſity, that we ſhould be interdicted all knowledge of thoſe ſublime objects, in which there are many things, whereof, or of their conſequences, we muſt confeſs our ſelves ignorant. Thus elder geometricians knew very well what a rectangular triangle was, when they conceived it to be a figure conſiſting of three ſtrait lines, two of which comprize a right angle ; though probably, for a great while, they did not know ſo much as all its chief properties or affections : ſince, for aught appears, before *Pythagoras*, (who offered a hecatomb to the muſes in gratitude for their diſcovery) it was not known, that the ſquare of the hypothenuſa is equal to the ſquares of both the other ſides ; and much more likely it is, that they were not able to ſolve thoſe difficulties (that continue to perplex even our age) which attend that endleſs diviſibility of lines, that is inferrible from that equality of the two ſquares to the ſingle ſquare.

And beſides the inſcrutable perfections of God, ſome of his works are ſuch, that, notwithſtanding the compleat knowledge of them ſurpaſſes our forces, yet there remain ſo many things, as well worthy to be known, as poſſible to be attained by us, that they will allow exerciſe enough to the wits of all the philoſophers in the world. And beſides that, as I have been ſaying, even about theſe priviledged ſubjects themſelves, divers conſiderable things may be diſcovered, if they were altogether impenetrable by our underſtandings, yet their number is ſo ſmall, that they would leave a large ſcope for human knowledge to diffuſe and improve itſelf. For it is not every thing, that is hard to be underſtood, or contrary to the common rules of probability, that has a right to paſs for a priviledged thing; for ſo the paradoxes about ſurd quantities, of iſoperimetral figures, duplicate and triplicate proportion, and divers other ſurpriſing doctrines, that are capable of mathematical demonſtrations, would be priviledged things. Nor are all thoſe worthy of this title, that are by many propoſed and embraced as philoſophical myſteries; for, ſuch are the Peripatetics ſubſtantial forms, which really are not priviledged things, but ſcholaſtic chimeras. But though I ſhall not preſume poſitively to ſet down the diſcriminating bounds and ſigns of priviledged things, yet moſt, if not all, of them being ſuch, as are either primary in their kind, as God himſelf, and the things, whoſe nature flows immediately from him; or elſe things, that if thoroughly inſpected, do neceſſarily involve the conſideration of ſome kind of *infinitum*; or elſe are ſuch, that, though in ſome main queſtions about them one ſide muſt be taken, both ſides are encumbred with abſurdities, or ſcarce ſuperable difficulties: thoſe, I ſay, being all (or ſome of them) the uſual marks, that belong to priviledged things, you will eaſily grant, that their number is not near ſo great as their abſtruſeneſs; and that therefore *Pyrocles* and his philoſophical friends need not fear to want employment for their curioſity. And for farther anſwer to his objection, I ſhall add, that we muſt regulate our belief by our perceptions, not our wiſhes; and muſt not conclude, that becauſe it were deſirable for us, that all things were penetrable to our human underſtandings, there is really nothing that is not ſo: and we can no more conclude, that we are as knowing as angels, becauſe we wiſh we were ſo, than that we are as immortal as they, becauſe we would never die. But as for thoſe few things, that have belonging to them properties ſo extraordinary, as to make it probable, even at the firſt ſight, that their nature muſt be very abſtruſe, and difficult to be fully diſcovered by us; I hope *Pyrocles* will allow, that things of ſo heteroclite a nature may challenge an exemption from ſome of the rules employed about common things; and that really ſuch rules as I mean, and ſome alſo of the vulgar notions, cannot always be ſafely extended to ſuch ſubjects, I forbear to ſhew in this place; only becauſe I would not too long at once interrupt *Arnobius*, and I expect to have a good opportunity to ſpeak again of this ſubject, before our conference be ended.

Timoth. You may then, I preſume, *Arnobius*, as ſoon as you pleaſe, favour us with your ſecond advice.

Arnob. I ſhall readily obey you, *Timotheus*, by propoſing it thus:

The ſecond Advice, or Rule.

That we be not haſty to frame negatives about priviledged things, or to reject propoſitions or explications concerning them; at leaſt, as if they were abſurd or impoſſible.

It is eaſy to obſerve in the ſpeculation of natural things themſelves, how unſafe it is not only to affirm, but in divers caſes alſo reject opinions, before men have any thing near a competent hiſtorical information of what belongs to the ſubject they take upon them peremptorily to judge of. And therefore it muſt in reaſon be thought much more unwary, to be forward to reſolve upon negative propoſitions, about things, which we ourſelves acknowledge to be above the reach of human reaſon, which ſince they are, it will become us at leaſt to forbear a rude and inſulting way of rejecting the opinions of learned men, that diſſent from us about ſuch things; ſince the ſublimity of the ſubject ſhould make miſtakes about them the more eaſy to be pardoned, becauſe they are difficult to be avoided; and our own ſharing in the diſability of penetrating ſuch abſtruſe things ſhould keep us from being over-confident, that we alſo may not be miſtaken, and incline us to tolerate other mens opinions about matters, wherein we ourſelves have but opinion, not ſcience.

Pyrocl. But have not you formerly adviſed us not to ſuffer ourſelves to be impoſed upon by proofleſs aſſertions, even about priviledged things?

Arnob. I did ſo, and do ſo ſtill: but there is a great deal of difference between believing a proofleſs affirmation about things, which the affirmer does not know to be true, and framing negative concluſions againſt opinions, which, for aught we yet clearly know, may be true; and therefore my preſent advice is very conſiſtent with my former: for here I counſel only, either a ſuſpenſion of judgment, when there appears no proof on either ſide ſufficient to ſway the intellect; or ſuch a wary and unprejudiced aſſent to opinions, that are but faintly probable, that the mind may be ready to receive, without either obſtinacy or ſurprize, any better argument, that ſhall conclude the contrary of the opinion we favoured before.

Eugen. But methinks it is hard to avoid the framing of conjectures, even about thoſe ſublime ſubjects, concerning which we can frame but conjectures, and thoſe often very ſlight ones.

Arnob. I CONFESS an abſolute ſuſpenſion of judgment is a very uneaſy thing, nor do I ſtrictly require you ſhould entertain no conjectures; but only that we ſhould conſider, that we may be eaſily miſtaken in them, and by further information ſee cauſe to lay them down, and perhaps exchange them for contrary ones. My thoughts of this matter may be perchance ſomewhat illuſtrated, by ſuppoſing, that we four were walking in a highway, and diſcovered, as far off as our eyes could reach, ſome erected and moving body of human ſtature; though we ſhould, by its ſhape and walking, ſafely enough conclude, that it were no other animal than a man, yet what manner of man he were, as old, or young, handſome, or ugly, we ſhould not be able to diſcern, and conſequently, could have no ſufficient ground to determine. And as if I ſhould affirm him to be a young man or handſome, you may juſtly cenſure me of raſhneſs; ſo if, becauſe I cannot prove my conjecture, you ſhould reſolutely deny, that he is a young man or handſome, I ſhould think you guilty, though not of an equal, yet of a cenſurable unwarineſs, becauſe, for aught you know to the contrary, he may be what I gueſſed him to be. And though we are naturally ſo uneaſy under fluctuation of mind, that for my part I confeſs (and it may be you may be ſubject to the ſame infirmity) I ſhould ſcarce forbear reſembling in my thoughts the man we ſpeak of to ſomebody or other that I knew; yet I ſhould juſtly think that conjecture to be very fallible, and both expect, that when I ſhould come to have a nearer and clearer view of him, I might ſee cauſe to diſmiſs my firſt idea for that, which this new and better proſpect would afford me, though it were quite differing from that I had formerly entertained, and ſhould repreſent him, that my forward thought perhaps reſembles to a young man of my acquaintance with black curled hair, and a ruddy complexion, to be pale and wrinkled, with grey hair curled like a pound of candles. The application, I ſuppoſe, I may ſpare.

BUT gentlemen, I would not be underſtood in the preceding diſcourſe, as if I were againſt all framing of negative propoſitions about priviledged things; my deſign being but to diſſuade from haſty ones: for ſometimes it is much more eaſy and ſafe to deny things, than to affirm them to belong to a ſubject that ſurpaſſes our reaſon. And the obſervation may be of uſe, eſpecially in two caſes; one, when the negative we aſſert is grounded not upon axioms taken from the uſual courſe of nature, or upon propoſitions dubious, or remote from the firſt principles of knowledge, but upon either catholic and metaphyſical axioms, or elſe upon truths manifeſtly flowing from ſome clear, though inadequate, notion we have of the nature of the things we treat of. The other caſe is, when we have a clear and ſufficient proof by revelation, or otherwiſe, of the poſitive attributes of the things we contemplate; for then we may ſafely deny of that ſubject any other thing, that is really inconſiſtent with that poſitive attribute. Upon which account it is, that though we do not fully comprehend what God is, yet knowing by the clear light of nature (and if we be Chriſtians) believing it upon the account of revelation, that he is a being intelligent and infinitely perfect, we may ſafely deny againſt *Epicurus*, *Vorſtius*, and Mr. *Hobbes*, that he is a corporeal ſubſtance, as alſo that he is mortal, or corruptible.

Pyrocl. I SHALL not trouble you, *Arnobius*, to enlarge upon your laſt advice, but willingly receive the favour of your next.

Arnob. WHICH ſhall be this:

The third ADVICE, or RULE.

That a matter of fact, or other truth, about priviledged things, being proved by arguments competent in their kind, we ought not to deny it meerly becauſe we cannot explain, or perhaps ſo much as conceive, the modus of it.

IT is no very difficult taſk to juſtify this advice; but I may do it the better, if you give me leave to frame and premiſe a diſtinction, for want of which I have obſerved a want of clearneſs in ſeveral diſcourſes, where the term modus has been employed: for ſometimes we would deny ſo much as a poſſibility, that one thing can belong to, or be truly ſaid of another; as when we ſay, we underſtand not how one creature can create another; or how there can be a line, that is neither ſtraight nor crooked; or a finite (whole) number, that is neither even nor odd. But moſt commonly we mean, by our not underſtanding the modus of a thing, that we do not clearly and diſtinctly conceive, after what manner the property or other attribute of a ſubject belongs to it, or performs its operations. The firſt kind of modus may, for diſtinction ſake, be called a poſſible modus; and the other, an actual modus. Now in both the foregoing acceptions of the term modus, we may find inſtances fit for our preſent purpoſe. For we cannot imagine, how a ſhort line, or other finite quantity can be endleſly diviſible, or (on the contrary) how infinite parts ſhould make but a finite total: and yet geometry conſtrains us to admit, that it is ſo. But though there be but few inſtances of this kind, yet of the other ſort of our neſcience of the modus of things, there may be found more inſtances than we could wiſh there were; for even in natural and corporeal things, the eager diſputes of the acuteſt philoſophers, and the ingenious confeſſions of the moſt judicious and moderate, ſufficiently manifeſt, that as yet we know not the manner of operating, whereby ſeveral bodies perform what we well know they bring to paſs. And not to enter into thoſe nice and tedious diſputes of the cauſe of the coheſion of the parts of matter in the ſmalleſt, moſt principal, and moſt primary bodies, perhaps without going out of our ſelves, the way, whereby the rational ſoul can exerciſe any power over the human body, and the way, whereby the underſtanding and the will act upon one another, have not yet been intelligibly explained by any. And the like I may ſay of the phænomena of the memory, eſpecially in thoſe, in whom that faculty is eminent. For it is a thing much more fit to be admired, than eaſy to be conceived, how in ſo narrow a compaſs, as part of a human brain, there ſhould be ſo many thouſand diſtinct cells, or impreſſions, as are requiſite to harbour the characters or ſignatures of many languages, each of them conſiſting of many thouſand differing words, beſides the images or models of ſo many thouſand faces, ſchemes, buildings, and other ſenſible objects, and the ideas of ſo many thouſand notions and thoughts, and the diſtinct footſteps of almoſt innumerable multitudes of other things: and how all theſe ſhall, in ſo narrow a compaſs, have ſuch deep and laſting impreſſions made for them, and be oftentimes lodged ſo exactly in the order, wherein they were at firſt committed to the memory, (and that perhaps many years before) that upon a ſudden command of the will, or a ſlight caſual hint, a whole ſet of words, things, and circumſtances, will in a trice, as it were, ſtart up and preſent themſelves even in the very ſeries, order, and manner, that ſo long before belonged to them. And I doubt not, but that beſides thoſe abſtruſe things about the modus, of which the more candid philoſophers have confeſſed their ignorance, there would many others have been taken notice of, if we did but as ſeriouſly and impartially enquire into the nature of all the things we are pleaſed to think we know. And when I reflect on the yet depending diſputes, between philoſophers and mathematicians, about the nature of place and local motion, which are things ſo obvious and familiar to us, I ſhould, though I had no other inducements, be inclined to think, that we ſhould find difficulties enough in many other ſubjects, wherein we do not now take notice of any, if we particularly ſtudied their nature; and that our acquieſcence in what we have learned about many things proceeds not from our greater knowledge of their nature, but from our having exerciſed leſs curioſity and attention in conſidering it.

AND if in things corporeal, that are the familiar objects of our ſenſes, we are often reduced to confeſs our ignorance of the modes of their inexiſting or operating, I hope it will not be denied, that to a being wholly unapproachable by our ſenſes, natural theology may be allowed to aſcribed ſome things, whoſe modus is not attainable by our underſtanding: as the divine preſcience of future contingents, which as it were impious to deny, as to the truth of the thing, ſo I fear it is impoſſible to explicate, as to the modus of it.

Eugen. IF it were at this time proper for me to meddle with things of that kind, I ſhould not much ſcruple to ſay in favour of the Chriſtian religion, that divers tenets, granted both by Chriſtians, Jews, and Heathens, as parts of natural theology, to me ſeem as difficult to be conceived, as divers of thoſe myſteries, that for their unintelligibleneſs are fiercely oppoſed in revealed theology. I will not take upon me to judge of others; but, for my part, I confeſs, I do not much better underſtand, how an intellect, and a will, and affections, are diſtinctly inexiſtent in God, in ſuch ſort as they are wont to be attributed to him, than how in him there can be a Trinity, ſtated, not as ſome ſchoolmen explicate, or rather darken it, but as the goſpel delivers it. I can as little explain by any thing in nature, how God, who is an immaterial ſubſtance, can move matter, as how he can create it: nor would it at all ſatiſfy me to tell me, that a rational ſoul moves a human body; for I do not allow, that it gives any motion to the body, but only guides that, which other agents have put the parts of it into. And though it did produce motion in the body, my ſcruple would yet remain; for the Carteſians themſelves confeſs, that the power the ſoul has of ſo much as determining the motion of the body belongs to it, not upon any phyſical account, but by the particular appointment and immediate power of God, who would have that power one of the conditions or properties of the union of the ſoul and body. So that to me, who deſire to have it explained, how an immaterial ſubſtance can move matter, and conſequently, how God can do it, it will be no ſatiſfaction to ſay, that the rational ſoul can move the body it is joined to, ſince that power is referred merely to God's appointment: and the queſtion is, how God himſelf can be conceived to move matter.

Arnob. I KNOW not, whether upon the ſame grounds, which I do not diſallow, I may not add, that whereas by many it is looked upon as an inconceivable thing, that God ſhould ſee mens thoughts, to me it appears as little intelligible, how he can know their outward actions: for ſince we have no way of diſcerning the particular motions of mens bodies, but by ſome of our ſenſes, eſpecially our ſight; and ſince thoſe ſenſations themſelves neceſſarily require organs duly conſtituted, that is, made up of divers parts, framed and joined after ſuch a determinate manner, I ſee not how we can explain the perception of viſible objects without an eye, or ſo much as any corporeal organ, or ſubſtance; eſpecially ſince it is, and that very juſtly, aſſerted, that the deity is not united to any portion of matter, as the human ſoul is to the human body. And to theſe inſtances others to the ſame purpoſe might be added, but that I think it fitter to mind you, that of thoſe already mentioned amongſt us there are ſome, that I preſume you will judge referable to that, which I lately called a poſſible modus; ſince, it ſeems, *toto genere*, as they ſpeak, inexplicable, how the attribute inexiſts in the ſubject, and after what manner the cauſe can produce the effect aſcribed to it.

Timoth. I KNOW you too well, gentlemen, to ſuſpect, you mean by this, to deny to God either the power of moving matter, or that of perceiving all its motions.

Arnob. You may well take that for granted; and you may remember, that to prevent miſtakes, I was careful, in propoſing my advice, to except thoſe things, for which there is ſome poſitive proof competent in its kind.

Pyrocl. ONE may then, without ſurpriſing you, aſk what kind of proofs thoſe may be?

Arnob. A FULL anſwer to that queſtion would take up too much of that little time, that is allowed us, before it grow dark, to go thorough the advices, that yet remain unſpoken of. But yet to comply with you, as far as my haſte will permit, I ſhall name two or three kinds of poſitive proofs, that may be employed on ſuch occaſions as we ſpeak of. And firſt, if there be an effect, that we diſcern muſt proceed from ſuch a cauſe, or agent, we may conclude, that ſuch a cauſe there is, though we do not particularly conceive, how, or by what operation it is able to produce the acknowledged effect. Thus, though a man, otherwiſe of a good judgment, being wholly a ſtranger to the mathematics, cannot conceive how a ſkilful aſtronomer can many years before-hand foretell eclipſes to a day and hour, and perhaps to a few minutes; yet when the ſucceſs does, as it often happens, verify ſuch predictions, he will be ſatisfied, that the maker of them had the ſkill to foreknow the things foretold in them. And ſo the generality of learned men among us, who are not ſo much acquainted with that part of navigation, which ſome moderns have by a Greek name called *Limen-Euretica*, or the art of ſteering to harbours, cannot well conceive, how a ſhip, that is, for inſtance, in the vaſt Atlantick ocean above a thouſand miles from any ſhore, ſhould be ſo directed, as to arrive juſt at a little harbour not cannon-ſhot over, which perhaps neither the pilot, nor any other in the ſhip ever ſaw. And yet as little as we can diſtinctly conceive, how ſuch an art of finding ports can be framed, we ſcruple not to allow there is ſuch an one, becauſe navigators to the *Eaſt* and *Weſt-Indies* could not without the guidance of ſuch an art find the remoteſt ports they are bound for.

A SECOND ſort there is of poſitive proofs, conſiſting of thoſe conſequences, that are clearly and legitimately inferred from any manifeſt acknowledged, or already demonſtrated truth. To this ſort belong divers mathematical propoſitions and corollaries, which though being nakedly propoſed they ſeem incredible to the generality of learned men, and ſometimes to mathematicians themſelves, are yet fully aſſented to, becauſe they clearly follow from either manifeſted or demonſtrated truths. Thus many cannot conceive, how it is poſſible there may be a million, for inſtance, of circles, (or as many more as you pleaſe) whoſe circumferences ſhall each of them come nearer and nearer to one another, and to a ſtrait line aſſigned, and yet none of them either touch, much leſs cut, either any other circle, or that line, but in one and the ſame point. And yet this is one of the odd propoſitions, that geometers have rightly deduced as corollaries from the ſixteenth of *Euclid*'s third element. And though we cannot clearly conceive, how two lines, that at their remoteſt ends are but little diſtant from each other, ſhould perpetually incline towards each other without ever concurring; yet geometricians, that is, the rigideſt reaſoners that we know of, have been compelled to admit this in the *Linea Conchoides* of *Nicomedes*, to name no more. But though, (not to touch the ſame ſtrings too often) I thought fit to mention theſe inſtances, yet whether you judge them ſufficient or no, you will allow that, which may be taken from the endleſs diviſibility of a line: for though, if I miſremembered not, *Sophronius* told me, he took notice to you, how unable we are to have a ſatisfactory apprehenſion, how a ſhort line as well as a long can be divided into more and more parts, without any ſtop; yet geometricians generally admit this, becauſe it may be clearly deduced from ſome geometrical truths, and particularly from the incommenſurableneſs of the ſide and diagonal of a ſquare. And if you will allow me to have once more recourſe to divine preſcience, I may add another acknowledged inſtance, by repreſenting, that philoſophers have admitted that, becauſe they judged it clearly to follow from the infinite perfections of God; though, how he can foreſee contingency, the moſt judicious and modeſt of them did not pretend their reaſon was able to conceive.

Timoth. To theſe two kinds of poſitive proofs mentioned by *Arnobius*, I doubt not but he will give me leave to add divine revelations, if competently atteſted ones can be produced; and therefore I will not, by going about to evince this, ſpend any of the time he reſerves for the remaining rules, to which he may, for me, advance as ſoon as he thinks fit.

Arnob. I ACCEPT the liberty you offer me, *Timotheus*, to proceed to my next advice; which is this.

The fourth ADVICE, or RULE.

That when we treat of priviledged ſubjects, we are not bound always to think every thing falſe, that ſeems to thwart ſome received dictate of reaſon.

As great a paradox as this may at firſt bluſh appear, yet it will need little more to make it out, than the application of ſome things, already delivered on occaſion of the two foregoing advices, of which this is indeed little more than a corollary. For it being evident, that as a great part of the dictates of reaſon are negative, ſo negative propoſitions do uſually ſpring from the repugnancy we judge that ſome things have to ſome poſitive dictate of reaſon; if thoſe poſitive dictates contain but gradual and limited truths, (to borrow *Sophronius*'s terms) and come to be unduly extended to privileged ſubjects, it may very poſſibly happen, that a thing may be really true, that yet muſt appear falſe, if it be judged of by its congruity to one of thoſe limited and but reſpective dictates of reaſon. It is alſo clear, that not only in philoſophy, but natural (as well as revealed) theology, the uſual ground, on which we reject many things, is, that we judge them unintelligible. And I cenſure not the practice in general, but I think it may eaſily miſlead us, when it is extended to things, that we may diſcern to tranſcend our reaſon, as, for aught yet appears, ſome of the modus's, even of things corporeal, are found to do. And we think we have made complete enumerations of the ſeveral ways of inexiſtence of an attribute in a ſubject, or of the operation of one thing upon another, when indeed we have overlooked one or other, and perhaps that, which we have thus pretermitted, may be the true one; though it may be alſo, that no attention and diligence of ours could, in ſome caſes, have ſerved our turn, the modus inquired after being not conceivable to us, though it may be to a higher than a human intellect.

Pyroc. The ſchool-philoſophers for many ages, in the catalogues they made of the ways of a body's working upon another at a diſtance, did not think of the true ways, by which odors and ſounds are communicated to us; and therefore had recourſe to certain unintelligible things, which they were pleaſed to call *ſpecies intentionales*. Whereas thoſe modern naturaliſts, that philoſophize freely, acknowledge, that odours are communicated by effluviums, exhaling from the odorous body, and fitted to affect our noſtrils; and ſounds are tranſmitted to the ear by the undulating motion, which the air is put into by the impulſe of the vibrating, or otherwiſe agitated parts of the ſonorous body.

Timoth. Methinks we need not go out of our ſelves to find inſtances of both the parts of what *Arnobius* was laſt ſaying, if we admit, as I queſtion not but we rationally may, this tenet of the generality of philoſophers, both ancient and modern, that the reaſonable ſoul is an immaterial ſubſtance: for then, whereas men think they have ſufficiently enumerated the ways of determining the motion of a body, by ſaying, that the determination muſt be made, either in the line, wherein the impellent, that put it into motion, made it move, or in the line, wherein it was determined to move by the ſituation of the reſiſting body, that it met with in its way; the motions of the animal ſpirits, if not alſo ſome other internal parts of the body, may, the body being duly diſpoſed, be determined by the human will; which is a way quite differing from the other. And how this attribute, I mean the power of determining the motion of a body, without any power to impart motion to that body, ſhould belong to an immaterial creature, which has no corporeal parts to reſiſt the free paſſage of a body, and thereby change the line of its motion, is not yet, nor perhaps ever will be in this life, clearly conceived by us men; though there is no doubt, but that he, who endowed the ſoul with this attribute or power, perfectly underſtands, both how it exiſts in the ſoul, and how the ſoul, by exerting it, operates on the body.

Pyroc. But can any thing ſeem more unreaſonable, than to embrace opinions, that contradict the rules of reaſon? which practice, if it be once allowed, why ſhould we trouble our ſelves to inveſtigate what is congruous or incongruous to reaſon, ſince the making a diſcovery, that an opinion is repugnant to it, will not aſſure us of that opinion's being falſe?

Arnob. A person leſs knowing and equitable than *Pyrocles* would have ſpared this double objection, if he had remembered what hath been formerly ſaid, applicable to our preſent purpoſe, and what kind of things they are, that we are diſcourſing of. But to remind him a little of them, I ſhall deſire him to conſider with me, that I no way diſallow the rejecting of opinions, that are found contrary to thoſe rules of reaſon, at the framing of which the things opined about were duly taken into conſideration: but in caſes not thought on when ſuch rules were deviſed, we are not always bound to ſubmit to be judged by them; and to maintain an opinion unconformable to ſuch a rule, may be not to oppoſe a genuine and abſolute dictate of reaſon, but to rectify one, that is erroneouſly thought ſo, by ſhewing, that the rule is expreſſed in more catholick and indefinite terms than it ought to have been. And of two opinions, you will not deny, that that is the moſt rational, that is moſt agreeable to thoſe rules of reaſon, that are framed upon the fulleſt information.

Eugen. It is not difficult to gather from what you have ſaid, *Arnobius*, that in the rule you propoſed to us, very few of the caſes, that occur in ordinary diſcourſe, or even in that of philoſophers, will be at all concerned. And in theſe few caſes, wherein you intend the rule ſhould take place, you are careful to obviate inconveniences by a double caution. The firſt, that you ſuppoſe, that the opinion, that claims an exemption from the common rules, is not an arbitrary or precarious tenet, but ſufficiently made out by proper arguments. And the ſecond, by declaring, that it is not to contradict right reaſon, but bad reaſoners, to give limitation to rules, that have been too haſtily framed and conceived in too general terms, by men, who either were not competently informed of the variety of particulars, when they took upon them to make analyſes and enumerations; or elſe preſumed to infer, that a thing was not, becauſe they did not underſtand the modus of its exiſtence or operation.

Arnob. You take my ſenſe right, *Eugenius*, and I have often thought, that the cauſes of the great clamor, that is made againſt ſome men, for not obſequiouſly ſubmitting to what ſome others call the rules of reaſon, are, that men do not ſufficiently underſtand the nature of things, and themſelves, but entertain too narrow conceptions of the former, and too high an opinion of the latter.

Pyroc. The dictates of reaſon being the ſureſt, if not the only ſafe rules, that nature has given us to frame our diſcourſes and ratiocinations by, I confeſs I am, though not fully reſolved, yet very unwilling to allow any concluſion, that is not conformable to them; or to admit, that any thing ſhould be ſo highly priviledged as to be exempted from the juriſdiction of reaſon, whoſe genuine declarations they are.

Eugen. THIS objection, *Pyrocles*, ſeems to me to be grounded rather upon an ambiguity of terms, than the true nature of things. For reaſon is often times taken for a ſet of notions and propoſitions, employed and acquieſced in by this, or that, ſort of reaſoners, that are wont to have names given them, from this or that particular diſcipline, as aſtronomy, chymiſtry, opticks, &c. of whoſe received doctrines they are ſuppoſed to be entirely maintainers. But it is alſo with, at leaſt, as much propriety uſed to ſignify the rational faculty itſelf, furniſhed with the light, that accompanies it, when it is rightly diſpoſed and informed. In the firſt of theſe two ſenſes it ſeems but reaſonable to allow, that ſome things ought to have the privilege to be exempted from being judged by ſome of the ſame rules, that are employed to judge of other things by; for ſome of theſe rules were framed upon a ſlight conſideration of common and familiar things, either by the vulgar, or by men, that for want of ſkill, or application of mind, did not critically conſider the diſtinct natures of things, and yet preſumed to ſettle rules, that other mens inadvertance, or lazineſs, has made them receive for certain dictates of reaſon: whereas other natures ſhould have been then conſidered, as well as thoſe; and by reaſon of their not having been ſo, the rules, I ſpeak of, are not always proper and ſafe, when they are applied to theſe overlooked natures. Thus ſucceſſive beings, as time and local motion, do, in ſome caſes, require to be eſtimated by other meaſures than ſubſtances, whether material, or incorporeal. And ſo alſo the more nice metaphyſicians, eſpecially among the moderns, have thought themſelves obliged to diſcourſe of moduſes, relations, privations, extrinſecal denominations, &c. in a very differing way from that which belongs to bodies and ſpirits; though the unſkilful (even among otherwiſe learned men) have been wont, and ſtill are apt, to confound all theſe ſubjects, by applying to them indiſcriminately the ſame rules, or, as they think them, dictates of reaſon.

BUT, beſides what may be ſaid of theſe long unregarded, or undiſtinguiſhed natures, there are other entities, that are more generally and familiarly taken notice of, wherein I may think one may find inſtances more appliable to my preſent purpoſe. For I obſerve, that though all other actual beings are compounded (to ſpeak in the language of the ſchools) of eſſence and exiſtence; yet, according to the notion of metaphyſicians, as well as divines, it muſt be acknowledged, that the ſimplicity of the Divine Nature is ſuch, as to exclude from God even this kind of compoſition. And indeed the notion we have of a being infinitely perfect, imports, that, though in no other being, yet in this thoſe two are inſeparable; for actual exiſtence, being a perfection, muſt needs belong to the nature of a being infinitely perfect. The generality of philoſophers, after *Ariſtole*, conceive place to be the immoveable and immediately contiguous concave ſurface of the ambient body, ſo that it is a kind of veſſel, that every way contains the body lodged in it; but with this difference, that a veſſel is a kind of moveable place, as when a bottle of wine is carried from the cellar to the table; but place is an immoveable veſſel, or a veſſel conſidered as immoveable. Now, ſuppoſing with *Ariſtotle*, and the generality of philoſophers, the plenitude of the world, it may be truly ſaid, that all plants, animals, minerals, ſtars, and other bodies, are each of them in ſuch an Ariſtotelian place, as has been deſcribed; whence it has been uſually ſaid by philoſophers, that what is in no place (I hope they meant it only of bodies) is not at all: yet it appears not, how the outermoſt heaven, whether that be the firmament, or no, I need not here inquire, can be properly ſaid to be in a place, ſince theſe philoſophers aſſerting the world to be finite, muſt grant there is no ambient body without it to contain it. And I ſhall add, on this occaſion, that if the outermoſt heaven ſhould be impelled, by the irreſiſtible power of God, in a ſtraight line, this way, or that way, there ſhould enſue a motion without change of place, for the outermoſt heaven was in none before, and does not, by its progreſſion, come to be contained by a new ambient body. And, in this caſe, even according to thoſe modern favourers of *Ariſtotle*, that approve *Des Cartes*'s definition of local motion, (which indeed is far more intelligible than *Ariſtotle*'s) the world may be ſaid to move without changing of place; for it does not paſs from the neighbourhood of ſome bodies to that of others, ſince compriſing all bodies, and yet being bounded, there is no body for it to leave behind, nor any beyond it for it to approach to. And though the Carteſians in their hypotheſis of the indefinitneſs of the world, do partly avoid the force of what I have been ſaying; yet, beſides what may be rationally urged to ſhew, that if the world be not more than indefinite, it muſt be really finite, I conſider, that the Carteſians, though upon grounds of their own, muſt allow what

I was obſerving; namely, that though every particular body in the univerſe is naturally capable of local motion, yet the univerſe itſelf is not; and though every particular body in the world have ſome determinate figure, yet the world itſelf, being indefinite, has not ſo.

WHEREAS *Ariſtotle*, and the philoſophers, that have lived ſince his time, have generally admitted the diviſion eſtabliſhed by him of all entities, into ſubſtance, and accident, and accommodated their rules to one of them, or both; the learned *Gaſſendus*, and his followers, have introduced a third ſort of things, as not being either ſubſtances, or accidents; and theſe, if you will admit, you will, I preſume, admit too, that they may be privileged from their rules calculated for other natures. Of this kind of things the Gaſſendiſts make place or ſpace to be; for they will not allow it to be a ſubſtance, becauſe it is neither body, nor ſpirit, but only ſomewhat, that has a capacity to receive or contain bodies, and would ſubſiſt, though God ſhould annihilate all the ſubſtances he has created. And for the ſame reaſon it is not to be called an accident, ſince that neceſſarily requires a ſubſtance to reſide in (according to that received axiom) *Accidentis eſſe, eſt ineſſe*; whereas in caſe of the annihilation of the world itſelf, and conſequently all ſubſtances that compoſe it, their place or ſpace would ſtill remain, and be capable of admitting a new world of the ſame extent, if God ſhould be pleaſed to create it: whence *Gaſſendus* wittily infers, that bodies are rather accidental in reſpect of place, than ſpace in reſpect of bodies. But without ſtaying to examine this paradox, I ſhall venture to ſay in general, that he who ſhall, with an heedful and unprejudiced eye, ſurvey the ſeveral hypotheſes, or ſyſtems, maintained by the different ſects of philoſophers, may find, that though the inſtances will not be all of them the ſame, yet there is none of theſe ſyſtems, in which one may not obſerve ſomething or other, to which every one of the rules, that reach to the other ſubjects treated of in that philoſophy, cannot ſafely be applied. And indeed the mind of man being naturally far more deſirous to know much, than to take the pains requiſite to examine, whether he does ſo or not, is very prone to think, that any ſmall number of things, that it has not diſtinctly conſidered, muſt be of the ſame nature and condition with the reſt, that he judges to be of the ſame kind. For by thus attaining to the knowledge of things, by way of inference, the mind gratifies, at once, both its vanity, and its lazineſs; looking upon theſe concluſions, as marks of the excellency of its rational faculty, whilſt they rather proceed from a want of the due exerciſe of it.

Pyroc. BUT if the received dictates of reaſon be not always ſafe grounds to proceed upon in our diſcourſe, I would gladly know, by what rules we ſhall judge of thoſe rules, and diſcover them to be erroneous in caſe they be ſo; and by what meaſures we ſhall eſtimate truth and falſhood, in thoſe things, wherein the uſe of thoſe rules muſt be laid aſide.

Arnob. YOUR double objection, *Pyrocles*, I confeſs to be weighty enough to deſerve a conſiderate anſwer; and to give you the ſum of mine, in few words, I ſhall tell you, that, in my opinion, ſince there is no progreſs *in infinitum* in the criteria of truth, and that our faculties are the beſt inſtruments, that God has given us to diſcover and to examine it by; I think a clear light, or evidence of perception, ſhining in the underſtanding, affords us the greateſt aſſurance we can have (I mean in a natural way) of the truth of the judgments we paſs upon things, whether they be other things, or the vulgar rules of reaſoning, or ſubjects, that claim a privilege from thoſe rules.

AND here give me leave to conſider, that it is not by induction, but by evidence, that we know, that *ex vero nil niſi verum ſequitur.* By which it appears, that the innate light of the rational faculty is more primary, than the very rules of reaſoning, ſince, by that light, we judge even of the lately mentioned axiom, which is itſelf the grand principle of ratiocinations made by inference.

Eugen. THIS matter may be, perchance, ſomewhat illuſtrated, by obſerving, that as the underſtanding is wont to be looked upon as the eye of the mind, ſo there is this analogy between them, that there are ſome things, that the eye may diſcern (and does judge of) organically, if I may ſo ſpeak, that is, by the help of inſtruments: as when it judges of a line to be ſtraight, by the application of a ruler to it, or to be perpendicular, by the help of a plumb-line, or a circle to be perfect, by the help of a pair of compaſſes. But there are other things, which the eye does perceive (and judge of) immediately and by intuition, and without the help of organs or inſtruments; as when, by the bare evidence of the perception, it knows, that this colour is red, and that other blue, and that ſnow is white, not black, and a char-coal black, not white; and ſuch a picture is very like, or another unlike to the face it was drawn to repreſent. For thus there are ſome things, that the intellect uſually judges of in a kind of organical way, that is, by the help of certain rules, or hypotheſes, ſuch as are a great part of the theorems and concluſions in philoſophy and divinity. But there are others, which it knows, without the help of theſe rules, more immediately, and, as it were, intuitively, by evidence of perception; by which way we know many prime notions and effata, or axioms metaphyſical, &c. as, that contradictory propoſitions cannot both be true; that from truth nothing but truth can legitimately be deduced; that two things, that are each of them equal to a third thing, are equal to one another; that a whole number is either even or odd. And it is alſo upon this evidence of perception, that we receive with an undoubted aſſent many primitive ideas and notions, ſuch as thoſe of extended ſubſtance or body, diviſibility, or local motion, a ſtraight line, a circle, a right angle, and many other things, that it would be here ſuperfluous to mention.

Arnob. I THINK the internal light, that the Author of Nature has ſet up in man's intellect, qualifies him, if he makes a right uſe of it, not only to apply the inſtruments of knowledge, but alſo to frame and to examine them. For, by the help of this light, the underſtanding is enabled to look about, and both to conſider apart, and compare together, the natures of all kinds of things, without being neceſſitated to employ in its ſpeculations the rules or dictates of any particular ſcience or diſcipline, being ſufficiently aſſiſted by its own light, and thoſe general axioms and notions, that are of a catholic nature, and perpetual truth, and ſo of a higher order, than the dictates or rules of any particular or ſubordinate ſcience or art. And by theſe means the underſtanding may perceive the imperfection and falſity of ſuch rules or theorems, as thoſe men, that look no higher, nor no further than their own particular ſcience or art, embrace for certain and unqueſtionable. Thus when philoſophers obſerved, that they could frame a clear notion of a thing, without conſidering, whether it were actually in being or not; or, even when they ſuppoſe, that it is not actually in being, as we can frame a clear conception of a roſe in winter, when there are none to be found growing, and have a clear notion of a myriagon, though it is very like there is no ſuch figure really exiſtent in the world; they have generally concluded, that the eſſence of things is differing and ſeparable from their exiſtence. And yet, when we conſider that God is a being infinitely perfect, and that actual exiſtence being a perfection, muſt belong to him, we may, by the ſame light of reaſon, that dictated eſſence and exiſtence to be two ſeparable things in all other beings, diſcern, that they muſt be inſeparable in God; and conſequently, that the fore-mentioned rule, though more general than almoſt any other, is not abſolutely univerſal, but muſt be limited by the light of reaſon. And thus alſo philoſophers conſidering, that not only all ſorts of bodies, but the immaterial ſouls of men, (and angels themſelves, ſuppoſing ſuch beings) are all endowed with qualities, which are accidents, have included it in the very notion of a ſubſtance, to be the ſubject of accidents, or, as the ſchoolmen ſpeak, *ſubſtare accidentibus*; and accordingly *ſubſtantia* is wont to be derived *à ſubſtando*: but the infranchiſed intellect finding in itſelf a notion of an abſolutely perfect, and therefore exiſtent being; and conſidering, that to be the ſubject of accidents is not a thing agreeable to the higheſt perfection poſſible, it concludes, that in God there are no accidents. And this concluſion has been embraced as a part, not only of Chriſtian, but of natural theology, and maintained by divers philoſophers themſelves, upon metaphyſical and other meerly rational grounds. In ſhort, the native light of the mind may enable a man, that will make a free and induſtrious uſe of it, both to paſs a right judgment of the extent of thoſe very dictates, that are commonly taken for rules of reaſon, and ſo frame others on purpoſe for privileged things, ſo far forth as they are ſo. But I fear, gentlemen, the fourth advice I have ventured to offer you, has, by its tedioufneſs, made you juſtly impatient of being detained by it ſo long; and therefore I ſhall advance to the fifth, which imports,

The fifth ADVICE, or RULE.

That where priviledged things are concerned, we are not always bound to reject every thing, as falſe, that we know not how to reconcile with ſome thing, that it is true.

Pyrocl. YOU may call this an advice, but I doubt others will ſtile it a paradox, and poſſibly think it one of the greateſt, that ever was broached.

Arnob. YET perhaps you will find by and by, that it may be in great part made good by what has been already diſcourſed, and by you admitted. I think it will not be doubted, but that there are, or may be conceived ſtraight lines, whereof one is a hundred or a thouſand times longer than another. It is alſo generally granted, that a longer line conſiſts of, or may afford, more parts than a ſhorter; for a line equal to the ſhorter being taken out of the longer, and conſequently juſt as diviſible as it is, there will remain of the longer line another line, perhaps many times exceeding the ſhorter line. And laſtly, it is generally acknowledged, that no number can be greater than infinite; ſince if the leſſer number were capable of acceſſion (as it muſt be, if it fall ſhort of another number) it would need that acceſſion (or a greater) to make it infinite, which yet it is ſuppoſed to be already.

Pyrocl. I SEE not yet, to what all this may tend.

Arnob. YOU will quickly perceive it, when I ſhall have deſired you to reconcile theſe propoſitions with the demonſtrations of geometers of the endleſs diviſibility of all ſtraight lines; whence they deduce, that though they be very unequal among themſelves, yet the ſhorteſt of them contains, or may afford, infinite parts.

Pyrocl. BUT is there any thing more clear to human underſtanding, or more ſuppoſed in almoſt all our ratiocinations, than that two truths cannot be contradictory to each other?

Arnob. THOUGH I am far from affirming, that one truth can really contradict another truth; yet I think that, which is but a gradual or limited truth, may in ſome few caſes not be reconcileable by us to an abſolute and univerſal truth. For, I think we may (with *Sophronius*) diſtinguiſh thoſe propoſitions we call true, into axioms metaphyſical, or univerſal, that hold in all caſes without reſervation; and axioms collected or emergent;

gent; by which I mean ſuch as reſult from comparing together many particulars, that agree in ſomething, that is common to them all. And ſome of theſe, though they be ſo general, that in the uſual ſubjects of our ratiocinations they admit of no exceptions, yet may not be abſolutely and unlimitedly true; of which I know not whether I formerly gave you an inſtance, even in that axiom, which (almoſt) all meerly natural philoſophers have ſuppoſed and built on, that, *ex nihilo nihil fit*, which, though at leaſt one of the higheſt of gradual or collected truths, may yet be not univerſally true, ſince, for aught we know, God, that is acknowledged to be a being, that is infinitely perfect, may have, and may have exerciſed, the power of creating. And in ſuch caſe as this, not to be able to reconcile a truth, concerning a priviledged thing, with a propoſition that generally paſſes for true, (and in other caſes is ſo indeed) will not preſently oblige us to reject either propoſition as falſe, but ſometimes, without deſtroying either, only to give one of them a due limitation, and reſtrain it to thoſe ſorts of things, on which it was at firſt grounded, and to which it was, becauſe of man's ignorance, or inconſiderateneſs, that it was not at firſt confined. And if the miracles vouchſafed either for the Chriſtian, or for any other religion, be any of them granted to be true; (as almoſt all mankind agrees in believing in general, that there have been true miracles;) it cannot well be denied, but that phyſical propoſitions are but limited, and ſuch as I called collected truths, being gathered from the ſettled phænomena of nature, and are liable to this limitation or exception, that they are true, where the irreſiſtible power of God, or ſome other ſupernatural agent, is not interpoſed to alter the courſe of nature.

Pyrocl. BUT do you think there are no inconſiſtent propoſitions, that you would call truths, wherein you cannot ſhew, that one of them is but a gradual or emergent truth?

Arnob. IT is one thing to enquire, whether men have yet diſcerned, or I am able to make out, that one of the propoſitions you ſpeak of is but a limited truth; and another, to enquire, whether, ſpeaking abſolutely and univerſally, it may to any intellect appear to be no more than ſuch. For firſt I conſider, that the reaſon, why we judge things to be repugnant, being, that the notions or ideas we have of them ſeem to us inconſiſtent; if either of theſe notions be wrong framed, or be judged of by an unfit rule, we may think thoſe propoſitions to be contradictory that really are not ſo; as, if you heedfully mark it, you ſhall find, that thoſe, that are wont to employ their imaginations about things, that are the proper objects of the intellect, are apt to pronounce things to be unconceivable, only becauſe they find them unimaginable; as if the fancy and the intellect were faculties of the ſame extent: upon which account ſome have ſo groſly erred, as to deny all immaterial ſubſtances, and choſe rather ſo far to degrade the deity itſelf, as to impute to it a corporeal nature, than to allow any thing to have a being, that is not comprehenſible by their imagination, which themſelves acknowledge to be but a corporeal faculty. But beſides this miſtake of things repugnant, which ariſes from the miſ-application or miſ-management of our diſcerning faculties; I conſider in the next place, that there may be another, that proceeds from the imperfection and limitedneſs of our underſtanding, which being unable to judge of priviledged things at the ſame rate that it does of other objects, may ſometimes be unable to diſcover that reconcileableneſs, that a more illuminated and penetrating faculty may diſcern. This may be illuſtrated by what uſually happens at ſea, (for there mens proſpect is the moſt free) when looking towards the main, the ſky and the waters ſeem to meet at the edge of the (ſenſible) horizon, though indeed they are as far diſtant as heaven is from earth; and on the other ſide, if you ſkilfully mix together the dry and fine powder of orpiment and that of indico, you will produce a green colour, as is known to painters, and the eye takes notice but of an uniform mixture, in which it ſees neither blue nor yellow: but if (as experience ſhews) you look on this mixture with a very good miſcroſcope, the emergent colour will diſappear, and you will plainly ſee, inſtead of it, blue and yellow grains of the powders diſtinct from one another. Which inſtances may ſerve to ſhew the imbecility of our viſive faculty; and the latter of them may teach us, that a thing may appear one and differing, as it is looked upon by a more or leſs diſcerning ſight. But an inſtance more home to our preſent purpoſe may be afforded by yellow diamonds, which, becauſe of their colour, not only other men, but the generality of goldſmiths (in whoſe error I have ſometimes ſhared) take to be counterfeit gems, or at beſt but right topazes; whereas very ſkilful lapidaries will by ſure ſigns diſcover and acknowledge them to be true diamonds, notwithſtanding their ſeeming difference from unqueſtioned ones, and account them to be of the ſame nature with that nobleſt kind of jewels. Whence we may learn, that a more ſkilful judge may diſcern an agreement in things, that almoſt all other men think they ſee manifeſtly to be of diſtant natures.

Eugen. GIVE me leave, gentlemen, to ſay on this occaſion, that I have ſeveral times obſerved, that men judge ſome things to be irreconcileable, not only when they are both of them repreſented to the underſtanding in the form of propoſitions; but when one of them is but a notion, or a current definition. For divers of theſe notions do contain in them a propoſition, or are equivalent to it; as when a circle is defined to be a figure contained in a line, all whoſe parts are equally diſtant from the middlemoſt point or center, this definition contains an affirmation of the eſſential property of a circle, and by the generality of geometricians is therefore diſcriminated from that conic ſection, which they call an ellipſis, though that be alſo a figure terminated by one curve line.

And becauſe you are verſed in mathematicks, I ſhall on this occaſion ſhew you by a geometrical inſtance, that if a man have not genuine and adequate notions of the things he judges of, he may confidently, and even upon very probable grounds, judge things to be inconſiſtent, that in reality are not ſo. For if an ordinary cultivator of mathematical diſciplines ſhould hear one man ſay, that ſuch a figure is an ellipſis, and another affirm it to be a circle, he would think their aſſertions to be inconſiſtent, having his mind prepoſſeſſed with an ellipſis's being a conical ſection, whoſe properties muſt therefore (he ſuppoſes) be very differing from thoſe of a circle; whereas ſuch wary geometricians as the learned Dr. *Wallis* * will tell him, that the vulgar notions of conic ſections are not adequate to the figures producible by them: for when a right cone is cut quite through by an inclining plane, the figure produced by the ſection agrees well with the received notion of an ellipſis, in which the diameters are of unequal length; yet if the plane cut the cone parallel to the baſis, that conic ſection will be a true circle, having all its diameters equal.

It is indeed an uncommon and unheeded account, but ſuch an one, upon which I have obſerved not only logicians, but philoſophers themſelves, to err about judging things reconcileable or inconſiſtent; that if a man be not ſufficiently acquainted with the nature of any of the two things under conſideration, (and much more if he be ignorant of, or miſtaken about both) he may think there is a contradiction between things, wherein a ſuperior, or more piercing intellect, may diſcern a conſiſtency: for taking it for granted, that he knows one thing to be a truth, if ſome other thing be affirmed to be ſo, which he has not underſtanding or ſkill enough to ſee how to reconcile to it; it is no wonder, that how well ſoever this may be evinced, he ſhould as little know how to admit, as how to reject it. This may be partly illuſtrated, and partly proved by inſtances, drawn from the mathematicks themſelves: for a novice in arithmetic, for example, finding that, according to his rules, there is not one mean proportional number between 4 and 32, will ſcarce be able to reconcile that propoſition to this other, that there are two mean proportionals between the mentioned numbers; for he may with great appearance of reaſon aſk, how, if there be not ſo much as one mean proportional, there can be two? Whereas thoſe, that are acquainted with the nature of ranks or ſeries of numbers proceeding in geometrical proportion, will eaſily diſcern, that between thoſe two recited, both the number 8, and the number 16, are mean proportionals.

Timoth. Though I diſallow not your inſtance, *Eugenius*, yet I ſhall be willing to hear one or two others of a leſs abſtracted nature.

Eugen. To obey you, *Timotheus*, I ſhall add, that if an old ſchool-philoſopher, or a mathematician, not acquainted with the latter diſcoveries made by teleſcopes, ſhould hear one man ſay, that the moon is the moſt enlightned, when ſhe appears full to us; and another affirm, that ſhe is more enlightned at the new moon than at the full, he would readily conclude, upon the ſuppoſition (which he makes no doubt of) that the moon receives all her light immediately from the ſun, that the affirmation of the latter (aſtronomer) cannot be true; which yet he would not conclude, if he knew (what is diſcovered by teleſcopes) that the moon is as well enlightned by the earth, as the earth by the moon; whereas at the full ſhe receives but thoſe beams, that come to her directly from the ſun, at the change ſhe receives both them in that part of her body that is obverted to him, and thoſe other beams of his, that are reflected from the terreſtrial globe to that part of the moon that is neareſt to us.

And to the foregoing inſtance I ſhall add one more, that ſeems appoſite enough to *Arnobius*'s purpoſe, and it is, that before *Pythagoras*, not only the vulgar of the Greeks, but their philoſophers and mathematicians too, obſerving oftentimes, that a bright ſtar preceded the riſing ſun, and that frequently alſo (on other days) after ſun-ſet, another ſtar appeared, that was none of the fixed ones; they confidently concluded from the ſo diſtant times of apparition, that the ſun was attended by two differing ſtars, to which accordingly they gave two differing names: but *Pythagoras*, who was a far better aſtronomer (as may be gueſſed, among other things, by his maintaining in thoſe early times the motion of the earth about the ſun) undertook to diſabuſe them, and effected it. Now if one, that had obſerved *Venus* only in the mornings, ſhould have affirmed, that beſides the ſix known planets, there was but a ſeventh (namely the phoſphorus) which preceded the riſing ſun; and another, (that had taken notice of her only in the evenings) ſhould aſſert, that beſides the ſame ſix known ones, the only ſeventh was that called *Heſperus*, which ſometimes appeared after his ſetting; a by-ſtander would preſently have concluded, that their aſſertions were not reconcileable, either to one another, or to the truth, which (in his judgment) was, that there muſt be no leſs than eight viſible planets: and yet *Pythagoras*, who had more ſkill, and more piercing wit, did, (as was lately noted) diſcern and teach, that theſe two phænomena were produced by one and the ſame planet *Venus*, determined by its peculiar motion (about the ſun) to ſhew itſelf near our horizon, ſometimes before he aſcends it, and ſometimes after he had left it. Such inſtances as theſe, though offered but as illuſtrations, may perſwade us from being too forward to reject every propoſition, that we ſee not how to reconcile to what we take for a truth; provided the diſtruſted propoſition

* See his treatiſe *de Sectionibus Conicis*.

tion be ſuch, as we would acquieſce in, if we could reconcile it to that ſuppoſed truth.

Timoth. FROM this diſcourſe, *Eugenius*, and that of *Arnobius*, which preceded it, I think one may gather, that, according to you two, when two propoſitions are laid down, whereof one is made evident to us by experience, or by reaſon, acting within its own juriſdiction or compaſs; and the other is ſufficiently proved by being mathematically demonſtrated, or duly atteſted by divine revelation, we ought not to reject either of theſe propoſitions, as no truth, meerly becauſe we do not yet know how to reconcile them: but we ſhould rather think, that the collected propoſition is but a gradual, or limited truth; or elſe we ſhould conſider, that we knowing but ſo imperfectly as we do the particular natures of priviledged ſubjects, for aught we know, a ſuperior intellect may be able to diſcern a friendly agreement between what is delivered about that ſubject, and the affirmation that ſeems repugnant to it, though we are not quick-ſighted enough to perceive this agreement. And this, how ſtrange ſoever you may think it, *Pyrocles*, may not only be countenanced by ſuch things as *Eugenius* lately had, but both you yourſelf, and almoſt all mankind do *de facto* ſeem to practiſe it, in the caſe of the divine preſcience of man's free actions.

Eugen. WHAT you contend for, gentlemen, may perhaps be thought the more receivable, if one ſhould argue thus: Firſt, either the propoſitions ſaid to be repugnant are both really true, or they are not; if it be anſwered, that they are not, the difficulty is at an end: for there is none at all to conceive a true propoſition ſhould contradict a falſe one. But, ſecondly, if both the propoſitions be ſuppoſed to be true, it muſt be affirmed, either that they are reconcileable, or that they are not; if it be ſaid they are not, then *Pyrocles*'s objection is out of doors; for it cannot then be reaſonable to ſay, that the two propoſitions, though inconſiſtent with one another, muſt neceſſarily be one or other of them inconſiſtent with the truth. But this I preſume he will by no means aſſert, and conſequently muſt ſay, that the propoſitions are reconcileable. Upon which anſwer I ſhall demand, how that can be, unleſs a ſuperior intellect, ſuch as unqueſtionably the divine is, can diſcover an agreement between propoſitions, wherein we cannot diſcern it? For our not being able to diſcern it is, you know, profeſſedly ſuppoſed in the caſe we diſcourſe of.

Pyrocl. BUT, *Arnobius*, will not this doctrine make us very liable to have falſities impoſed on us, at the pleaſure of bold and dictating men?

Arnob. NOT, if it be limited to the ſubjects, wherein alone I would have it admitted: for if neither of the things treated of be a priviledged one, but both in the juriſdiction of ordinary reaſon, I do not only conſent, but (in my firſt advice) require, that the propoſitions framed about them be eſtimated according to the common dictates of reaſon. And even in caſes, where one of the propoſitions is about a priviledged thing, I do not at all think fit, that it ſhould be received in ſpite of its being repugnant to the gradual truth delivered in the other, unleſs it can by ſome other argument, ſufficient in its kind, be proved to be true; and in that caſe, that what I plead for ought to be admitted, is employed by the ſuffrage of almoſt all mankind in that caſe, which was juſt now pertinently mentioned by *Timotheus*: for though men know not how to reconcile the liberty of man's will with the infallible knowledge, that God has of thoſe actions that flow from it, yet they have unanimouſly judged it reaſonable to believe both free-will and preſcience; the former, becauſe they felt it in themſelves; and the latter, partly becauſe the fore-knowledge of things being manifeſtly a perfection, ought not to be denied to God, whom they looked upon as a being ſupremely perfect; and partly becauſe ſome actions and events, that they all judged to flow from mens free-will, were, as the generality of men believed, foretold by prophetic oracles. But except in ſuch caſes as I have been naming, I am altogether of *Pyrocles*'s mind, that ſince we have ſcarce any way of diſcovering a falſity, but by its being repugnant to ſomewhat that is true; to deny, that in caſes within the juriſdiction of ordinary reaſon, the repugnancy of a propoſition to any manifeſt truth ought to ſway our judgments, were to deprive us of the uſefulleſt *criterion* to diſcriminate between falſhood and truth.

Timoth. FOR my part, who believe with many philoſophers, as well Heathen as Chriſtian, that human ſouls owe their origin to God, and with almoſt all philoſophers, (for I know what the *Stoicks* held) that as he is the ſupreme being, ſo he is a moſt free agent, I ſee not why, as he has given to corporeal beings divers qualities, very differing in their degrees of nobleneſs; ſo he might not give to the intelligent productions of his power and will various degrees of intellectual capacities, as well as a limitedneſs of nature. And as it will not follow, that becauſe we can ſee with our eyes very ſmall objects, and imagine ſuch as are yet much ſmaller, either the eye or the imagination can ever reach to ſo ſmall an object as an atom; ſo it will not follow, that becauſe we are able to frame conceptions of immaterial beings, we muſt therefore be able to underſtand the nature of God, and the harmony of all his monadical attributes. A little boy may have a clear notion of three, four, five, or other ſmaller numbers, and yet may be unable to frame good conceptions of triangular and other polygon numbers, (as ſome call them,) and much more of the abſtruſe affections of ſurd numbers, and the roots of the higher algebraical powers. To diſcern particular truths is one thing, and to be able to diſcover the intercourſe and harmony between all truths, is another thing, and a far more difficult one; as a traveller may upon the Engliſh ſhore know, that he ſees the ocean, and upon the coaſt of *Africk* be made to do the like; and at the *Eaſt-Indies* alſo he may know, that he ſees the ocean; and yet not know how thoſe ſo diſtant ſeas communicate with each other, though that may be manifeſt enough to a coſmographer.

Arnob. WHAT you ſay brings into my mind, that I have ſometimes thought God and men enjoy truth as differingly as they do time. For we men, as we enjoy time but by parcels, and always leave far the greateſt part of it unreached to by us; ſo we know but ſome particular truths, and are always ignorant of far more than we attain to. Whereas God, as his eternity reaches to all the portions of time (or meaſured durations) ſo his omniſcience gives him at one view a proſpect of the whole extent of truth: (as if a man could ſee the whole river of *Nilus* with all its turnings and windings, from its hidden ſprings to its entrance into the ſea.) Upon which account he ſees all particular truths, not only diſtinct, but in their ſyſtem, and ſo ſees a connexion between thoſe, that to us ſeemed the moſt diſtant ones.

Arnob. THERE remains now, gentlemen, but one part more of your penance to be undergone; for it is high time I ſhould haſten to the relief of a patience I have ſo long diſtreſſed; and therefore I ſhall give it but one exerciſe more, and conclude your trouble with ſome reflections on this laſt advice.

The ſixth ADVICE, or RULE.

That in priviledged things we ought not always to condemn that opinion, which is liable to ill conſequences, and incumbred with great inconveniencies, provided the poſitive proofs of it be ſufficient in their kind.

THAT this advice may be the more eaſily admitted, I ſhall ſeparately ſuggeſt three things, which I deſire may be afterwards conſidered all together.

FIRST, that clear poſitive proofs, proportionate to the nature of things, are genuine and proper motives to induce the underſtanding to aſſent to a propoſition as true; ſo that it is not always neceſſary to the evidence and firmneſs of an aſſent, that the intellect takes notice of the conſequences, that may be drawn from it, or the difficulties, wherewith it may be incumbred. This is plain in thoſe aſſents, which of all others, at leaſt that are meerly natural, are by knowing men thought to be the moſt undoubted and the beſt grounded; I mean the aſſents, that are given to the truth of geometrical demonſtrations: and yet, *Euclid*, for inſtance, in all his elements of geometry, in ſome of which ſurpriſing paradoxes are delivered, (as in the ſixteenth propoſition of the third book, and the 117th of the tenth book, to name no more) contents himſelf to demonſtrate his aſſertions in a mathematical way, and does not, that I remember, anſwer or take notice of any one objection: and the geometricians of our days think they may ſafely receive his propoſitions upon the demonſtrations annexed to them, without knowing or troubling themſelves about the ſubtleties employed by the ſceptic *Sextus Empiricus*, or others of that ſect, in their writings againſt the mathematicians, and all aſſertors of aſſured knowledge.

THE ſecond thing I would offer to your conſideration, is, that the former part of our diſcourſe has manifeſted, that there are ſome things, which our human and imperfect underſtandings either cannot, or at leaſt do not, perfectly comprehend; and that, nevertheleſs, men have not refrained from preſuming to dogmatize, and frame notions and rules about ſuch things, as if they underſtood them very well. Whence it muſt needs come to paſs, that if they were miſtaken (as in things ſo abſtruſe it is very like they often were) thoſe, that judge by the rules they laid down, muſt conceive the propoſitions oppoſite to their miſtakes to be liable to very great, if not inſuperable difficulties and objections.

AND this ſecond conſideration, in conjunction with the firſt, will make way for the third, as a natural production of them; which is, that, as we need not wonder, that priviledged things, which are wont to be ſo ſublime as to have been out of the view of thoſe that framed the rules, whereby we judge of other things, ſhould be thought liable to great objections by them, who judge of all things only by thoſe rules; ſo we ſhould not require or expect more evidence of a truth relating to ſuch things, than that there are for it ſuch ſufficient poſitive reaſons, as, notwithſtanding objections and inconveniencies, make it, upon the whole matter, worthy to be embraced.

Pyrocl. BUT can that be worthy to be aſſented to, which is liable to objections and inconveniencies, which the maintainers confeſs they know not how to avoid? Does not your *Euclid* himſelf, in ſome of his demonſtrations, employ that way of reaſoning, which ſome of his Latin Interpreters call *deductio ad abſurdum*?

Arnob. *EUCLID* indeed, (as well as other mathematicians) beſides that more ſatisfactory way of direct probation, which perhaps he might have oftner employed than he did, has ſometimes, where he thought it needful, made uſe of the Επαγωγη you ſpeak of. But in theſe caſes he never goes out of the diſcipline he treats of, and confining himſelf to arguments drawn from quantity, he urges nothing as abſurd, but what is undeniably repugnant to ſome truth he had already demonſtrated, or to thoſe clear and undiſputed definitions, axioms, or poſtulata, which he ſuppoſes to have been already granted by thoſe he would convince. But though he thus argues, to prove, that his readers cannot contradict him without contradicting themſelves; yet we find not, that he was at all ſollicitous to clear thoſe difficulties, that ſo quick-ſighted a man could not but know ſome of his theorems to be attended with: but contents himſelf to demonſtrate the incommenſurableneſs of the ſide and diagonal of a ſquare, without troubling himſelf to take notice of the difficulties, that attend the endleſs diviſibility of a line, which would follow from what he demonſtrated. But, *Pyrocles*, to look back to the firſt part of your objection, though what you ſay will hold in ordinary caſes; yet ſuch peculiar ones, as we are ſpeaking of, deſerve a particular conſideration. About ſome priviledged things there are, and about ſome others there may be contradictory opinions (taking that term in a ſtrict ſenſe) maintained. Now as both of theſe cannot be true, ſo one of them muſt be ſo: as, though it be hotly diſputed, whether quantity be endleſly diviſible, yet certainly either it muſt, or muſt not be diviſible without end: and, as was formerly obſerved, which ſide ſoever you take, the inconveniencies will be exceeding great, and perhaps there will lie objections ſcarce to be directly anſwered. And ſince one of the two oppoſite opinions muſt be true, it will not always be neceſſary, that an opinion muſt be falſe, which is incumbred with great difficulties, or liable to puzzling objections. And therefore if the poſitive proofs on one ſide be clear and cogent, though there be perplexing difficulties objected by the other, the truth ought not for their ſake to be rejected; becauſe ſuch difficulties proceeding uſually either from notions, that men preſume to frame about things above their reaches, or from rules, that were not made for ſuch points as are in diſpute, the objections are not to be judged ſo well founded, as is that acknowledged principle in reaſoning, that from truth nothing but truth can be legitimately inferred.

Eugen. I CONFESS I have always thought it reaſonable in ſuch caſes, to compare, as well the poſitive proofs of one opinion with thoſe of the other, as thoſe objections that are urged on either ſide; and there make my eſtimate upon the whole matter, though with a peculiar regard to that opinion, that has a great advantage in point of poſitive arguments; becauſe, as *Arnobius* obſerved, thoſe are the proper inducements to the aſſent of the intellect: and then the objections may well enough be ſuſpected to proceed from the abſtruſe nature of priviledged things, and the over-great narrowneſs of the rules, that men are wont to judge of all things by: for we may have a ſufficiently clear proof, that a thing is, whilſt we have no ſatisfactory conception of its manner of exiſting or operating; our illative knowledge, if you will allow me ſo to ſpeak, being clearer, and extending further, than our intuitive or apprehenſive knowledge.

Arnob. BUT even about things, that we cannot ſufficiently underſtand, we may in ſome caſes exerciſe our reaſon in anſwering objections, that are thought not to be at all anſwerable, becauſe they are not directly ſo. For we may ſometimes ſhew, by framing in another caſe a like argument, which the adverſary muſt confeſs does not conclude well, that neither does the argument, that contains his objection, conclude aright.

THIS I could exemplify (though that may ſeem no eaſy taſk) but that I fear I ſhould want time to propoſe examples, whoſe being very paradoxical would make them need much proof; which you who, I fear, are quite tired already, would want patience to hear. Wherefore I ſhall rather recommend to you one obſervation, which I take to be of no ſmall moment and uſe, when we contemplate things of the nature of thoſe we have been diſcourſing of; and it is this, that we muſt not expect to be able, as to priviledged things, and the propoſitions that may be framed about them, to reſolve all difficulties, and anſwer all objections; ſince we can never directly anſwer thoſe, which require for their ſolution a perfect comprehenſion of what is infinite: as a man cannot well anſwer the objections, that may be made againſt the *Antipodes*, the doctrine of eclipſes, that of the different phaſes of the moon, and of the long days and nights of ſome months apiece near the poles, (not now to name that more abſtruſe part of aſtronomy, the theory of the planets) unleſs he underſtand the nature of the ſphere, and ſome other principles of coſmography. So that where priviledged things are concerned, clear and poſitive arguments ought to be of great weight in favour of the opinion they conclude for; even when on the contrary ſide, we may diſcourſe ourſelves into ſuch difficulties, as may perplex, and perchance poſe our limited underſtandings.

Eugen. THIS is a point of ſuch abſtruſe ſpeculation, that if, when we remember ourſelves to be but men, it ſhall be thought fit to adventure upon launching out into it, it will be neceſſary to adjourn the proſecution, till we ſhall have more time before us, than we are maſters of now, that the hour is ſo late, that it is high time we ſhould, after our deſerved thanks to him, releaſe *Arnobius*, by wiſhing him a good night.

NEW
EXPERIMENTS
AND
OBSERVATIONS
Made upon the
ICY NOCTILUCA.

To which is added

A CHYMICAL PARADOX, grounded upon NEW EXPERIMENTS, making it probable; that CHYMICAL PRINCIPLES are tranſmutable; ſo that out of one of them others may be produced.

An ADVERTISEMENT of the PUBLISHER to the READER.

THOSE, who have publiſhed ſome former tracts of this honourable author's, have made their complaints, that his writings have not met with the ſame candor and ingenuity from all writers: for though ſome have very civilly mentioned his name in thoſe experiments, obſervations, and phænomena, which they have borrowed from his writings; yet others have vendicated that to themſelves, which was none of their own; for having lighted their candle at his torch, and raiſed ſome ſuperſtructures upon thoſe foundations he had laid, they have made no mention of him at all; in which matter the ſincerity of philoſophers is not a little required.

IT is known, that Mr. *Boyle* was the firſt inventor of that pneumatic engine, or air-pump, called from him, *Machina Boyliana*; the figure and many of the uſes whereof he hath deſcribed in his tract, entituled, *New phyſico-mechanical experiments concerning the ſpring and weight of the air*, (and in the continuation of it;) which book, being tranſlated into *Latin*, and diſperſed into foreign parts, hath given occaſion to tranſmarine virtuoſi to make eſſays (not altogether unſucceſsful) concerning the fabricating of the like engines; though none of their tracts upon that ſubject have equalled the original. In like manner, it is highly probable, that his diſſertations concerning phoſphorus's, and his free diſtribution of ſeveral parcels of that luminous ſubſtance, have excited others to deſcant upon the ſame ſubject.

BUT that it may juſtly appear, that the honourable author ſhines only by his own light, and hath not any thing mutuatitious in the following treatiſe, the reader is to be advertiſed, that this tract had much earlier come abroad, if, after I had received the whole, even to the laſt ſheet, in 1681, that ſo the Engliſh edition, and my Latin verſion thereof (wherewith the noble author was willing to gratify the curious in foreign parts) might be carried on together, I had not been by long ſickneſs, and divers unfavourable circumſtances, obliged to retain it ſome months in my hands.

WHICH I am the more troubled at, becauſe I find, that my neceſſitated delay hath given opportunity to the publication of ſome experiments about noctiluca's. But the virtuoſi, who have the honour to be acquainted with the noble author of this book, and have ſeen the laſt ſummer and autumn divers of the chief experiments made, which are mentioned therein, will eaſily believe, that the author needed not to borrow any thing from thoſe ſpecimens, which have been lately publiſhed by an ingenious man about noctiluca's; which, beſide that they contain but few phænomena, or trials coincident with his, were ſo far from affording him any information, that (to be ſure to be no borrower) he never would to this day read any one of them, or hear them read. And it appears, by the cloſe of the aerial noctiluca, preſented in print to the Royal Society, towards the end of the year 1680, that he then knew, and had practiſed, ſeveral other ways of making noctiluca's, than that, which he then, and before any other man, imparted to the world.

THE uſefulneſs of the enſuing diſcoveries and reflexions will be beſt judged of by diſcerning readers, who therefore need not to be previouſly informed thereof by me.

The PREFACE.

SIR,

THE very kind reception you were pleaſed to give thoſe papers about the aerial noctiluca, that I addreſſed to you about the beginning of the laſt winter, does not only invite me, but in a manner oblige me to impart to you ſome trials, that I made, after I had ſent you the others, about the ſame kind of phoſphorus; to which you may now be pleaſed to annex them, by way of continuation or appendix. But that being true, which is noted by *Lucretius*, where he prettily ſays, that——*res accendunt lumina rebus*, you will not think it ſtrange, that if this obſervation holds in other things, it ſhould particularly take place in luminous things themſelves. And therefore, without any further preamble, I ſhall tell you, that, whilſt my occaſions permitted me to ſtay in *London*, I was willing to try, whether I could carry on ſomewhat further that, which had already been not unſucceſsfully begun. And accordingly I cauſed to be prepared and diſtilled four or five ſeveral materials, which I thought the curious, eſpecially thoſe addicted to chymiſtry, would wiſh to have had trials made upon, and would perhaps blame me, if I had omitted to employ. But thoſe materials not anſwering what was deſired, we made choice of another or two, which I forbear to name, for certain reaſons, and particularly for this, becauſe they are to be found but in very few places, and perhaps would not have ſerved my turn, if I had not luckily procured them in a ſeaſon, whoſe dryneſs continued almoſt to a wonder.

FROM theſe materials ſometimes, and ſometimes alſo from the dried reſidence of urine, we obtained now and then ſome of the aerial noctiluca, ſuch as that you have hitherto received accounts of; but more frequently a nobler ſort of phoſphorus, about which I now proceed to impart to you ſome obſervations, as I did, without any curious method or ornament, ſet them down from time to time, as I happened to make or remember them. And, to facilitate the pardon I beg of you, for having omitted ſome experiments, that perhaps you will wiſh I had made, I muſt acquaint you, that being by ſome neceſſary occaſions enforced to leave *London* for a much longer time than I have done for ſeveral years laſt paſt, I have been obliged to make moſt of the following trials in a ſmall village, where I yet am, and where, being unaccommodated with furnaces, inſtruments, and other chymical and mechanical conveniences, for making and varying experiments, you receive an account, not of all the trials I would have made, (ſome of the chief of my catalogue remaining ſtill unattempted) but of all thoſe I could make in my preſent circumſtances. However, ſuch as they are, I think not fit to delay any longer the acquainting you with them; and therefore have ordered them to be gathered into one ſmall collection of memoirs, to which paper I have given the title of *the glacial or icy noctiluca*, not only to diſtinguiſh it from the aerial one, whereof you have already had an account; but for another reaſon, that you will quickly meet with in the little tract itſelf, from whoſe peruſal I muſt not now any longer detain you.

AN
APPENDIX
TO THE
AERIAL NOCTILUCA.

SECT. I.

THE ſhining matter, contained in our beſt phials, being partly waſted in experiments, and partly given away, I thought fit to try, whether by the help of heat and other motion, our want might not be ſomewhat ſupplied, till more noctilucous matter could be prepared.

EXPERIMENT I.

IN purſuit of this deſign, I took an old phial, that had been long laid aſide as uſeleſs, becauſe the matter had been poured out of it into a clearer and ſmaller glaſs; and having held that ſide of this phial, to which I perceived ſome feculent matter ſtuck, near the fire, till it had conceived a conſiderable degree of warmth, I removed it into a dark place, and, as I expected, found it to ſhine, and that vividly enough, whilſt it retained a competent degree of heat; and when it cooled too much, the light ceaſed with the agitation, that as a cauſe or a condition accompanied it. But if afterwards the phial were again held to the fire as before, the ſhining power would be excited, and the ſplendor would continue a pretty while. But after ſome days or weeks (for I remember not which,) this diſpoſition to be made luminous by external heat was utterly loſt.

Experiment II.

Having alſo taken notice of a little feculent ſtuff, that ſtuck to the inſide of the glaſs, that had contained ſome of our noctilucal matter, I imagined, that though it would not ſhine in the dark by the contact of the air, to which it had been too long accuſtomed; yet when once that diſpirited or diſanimated ſuperficies, (if I may ſo call it,) that had lain expoſed to the air, was removed, the more internal part of the matter might not be deſtitute of a ſhining power. I carefully ſcraped off the outermoſt ſurface, and rubbing a little of the reſt with my finger upon my hand, I found it to ſhine well enough. And though the matter, being once more left expoſed to the air, did loſe in its ſuperficial parts the virtue of ſhining in the dark; yet thoſe parts being taken off, the remaining matter (being rubbed) did not appear deſtitute of a luminous quality; ſo that it ſeemed, that though the air did, after a while, mortify, as it were, and ſpoil the ſuperficial parts, that were expoſed to its immediate contact, yet this vitiated ſurface ſerved for a kind of cover or fence to the matter, that lay beneath it, and kept it from evaporating or ſpending thoſe ſpiritious or ſubtile parts, on whoſe account it was capable of becoming luminous.

Experiment III.

And as I had obſerved on other occaſions, that liquors abounding in tenacious parts, though the liquors did not appear opacous or feculent, would leave ſticking to the inſides of the glaſſes, that contained them, ſomewhat, that though generally not perceived, becauſe not very manifeſt, was by ſome other ways, that I had tried, diſcoverable; having, as I was ſaying, obſerved this, in ſome other caſes, I ſuſpected, that even in a phial, that had formerly contained ſome of our ſhining ſubſtance, though it ſeemed to have been well emptied, and to have no groſs feculency adhering to it, there might ſtick ſomewhat, which, though unobſerved by the naked eye, might be made viſible to the naked eye by heat or motion. In purſuance of this conjecture, I took this glaſs; and having crackt it into fragments, that it might be put into the neck of a phial of a convenient ſhape and ſize; and having well ſtopt the veſſel, and removed it into a dark place, we there ſhook it, and had the pleaſure to ſee, not only that light was readily produced by the motion excited in the juſtling of the parts one againſt another, but that, by reaſon of the various poſition of the fragments of glaſs, ſome looking upwards, ſome downwards, ſome to the right hand, and ſome to the left, the light ſeemed to be vibrated every way with a very delightful vividneſs. This production of a kind of blazing light was often repeated with theſe broken pieces of glaſs, and if the phial were heated, the effect ſeemed more quick and conſiderable; and (if I miſremember not,) by only warming the phial, without ſhaking it, a light would be produced.

Experiment IV.

Afterwards having beaten ſome of the glaſs into ſuch ſmall pieces as were capable of paſſing through the neck of a glaſs-egg with a flat bottom, that it might ſtand upright of itſelf, we hermetically ſealed up the neck, to try whether, by this hindring the included matter from exhaling or tranſpiring, we could keep the beaten glaſs always fit to exhibit the phænomenon: but we found not the event anſwer our deſires; for after no long time, we could no more produce any light in our ſealed veſſel, though an unlucky accident happening in one of our laſt trials, keeps me from being fully ſatisfied of the unpracticableneſs of the thing deſigned.

Experiment V.

In the printed tract of the aerial noctiluca, there is mention made of ſome liquor, that was hermetically ſealed up in a bolt-glaſs, that was not great, to try, whether by this way we could for any long time preſerve the ſhining faculty of that liquor, wherein it was already exceeding faint, and not to be excited but by a conſiderable degree of heat, and a vehement agitation of the veſſel itſelf. This ſealed glaſs having been left in the corner of a window, for what was judged a competent time, we yeſternight approached the veſſel by degrees to the fire, and ſhaking it from time to time, till the included liquor had acquired a conſiderable degree of heat; then removing it to a dark place, and ſhaking the veſſel ſomewhat ſtrongly, we perceived, that the diſpoſition the liquor had to ſhine was very much impaired, but not quite aboliſhed. For there would from time to time, upon the rude agitation it was put into, appear little portions of matter, that looked prettily, and ſhone very vividly, like ſparks of fire; and ſome of theſe appeared in the ſpherical part of the glaſs, and ſome in the neck; ſome of them ſeemed as it were fixed to their firſt ſtation, and others moved upwards and downwards, and moſt of them continued ſome time to ſhine a pretty while before they diſappeared; and when they vaniſhed, few of them did ſo by degrees, but each luminous ſpeck, when it had laſted out its time, loſt its whole light at once.

SECT. II.

THE new liquid phoſphorus, I lately mentioned to have been made ſince the publiſhing the aerial noctiluca, was poured into a large phial, that might contain (by our gueſs) ten or twelve times as much as was put into it; ſo that the ſhining matter, having ſo much air included with it, might thereby be aſſiſted to diverſify at leaſt ſome of the phænomena afforded by former noctilucas.

OBSERVATION I.

AND accordingly I obſerved in the firſt place, that though the ſhining ſteams filled the whole cavity of the large glaſs, that was untaken up by the liquor and the reſidence, and this lighter flame continued much longer at once, than any we have hitherto mentioned, for it continued vivid ſeveral days and nights together, without ever unſtopping the phial to give it freſh air. And, if I miſremember not, I obſerved it to do ſo for about a week, before my occaſions hindered me from obſerving it any longer.

OBSERVATION II.

I SOMETIMES took notice with pleaſure, that ſome exhalations or vapours, that appeared conſiderably luminous, ſeemed to roll to and fro, like little clouds or aggregates of ſmoak, in the cavity of the veſſel, though it ſeemed difficult to determine, what ſhould give them, and maintain in them, ſuch a motion.

OBSERVATION III.

THE bigneſs of the glaſs being conſiderable, it happened, that ſometimes when I went into the darkned place where I kept it, ſo much luminous matter would make a ſurpriſing ſhow; but though its extent were far greater, yet its intenſity did not much exceed that of the light afforded by the noctilucas of the firſt ſort, as, for diſtinction's ſake, thoſe may be called, that are mentioned in the printed account. Only this I often took notice of, that, in caſe I ſhook the matter gently, the light would appear much more vivid, and, as it were, would flaſh in and about the ſurface of the liquor where it was contiguous to the air, than it did elſewhere. And this ſplendor was ſuch, that if it had been laſting, I thought it would have made our phoſphorus uſeful for conſiderable purpoſes.

OBSERVATION IV.

WHEN after having ſo many days kept this glaſs ſtopt, at laſt it would not longer ſhine of itſelf, we ſuppoſed it to be reduced to the condition of a phoſphorus of the firſt ſort; and accordingly found, that upon the removal of the ſtoppel, and ingreſs of freſh air, the cavity would in a moment be filled with fumes, that looked white in an enlightned place, but luminous in a dark one, and (probably by reaſon of the quantity of the air contained in ſo capacious a glaſs) the light uſually continued much longer than it was wont to do in noctilucas of the firſt ſort.

OBSERVATION V.

BEING deſirous to try, whether this more vigorous matter, if it were kept ſo exactly ſtopped, that none of the luminous vapours could exhale, would not laſt very long, I put near two ſpoonfuls of the liquor, with ſome of the ſediment, into a bolt glaſs (with a flat bottom, that it might ſtand without leaning) capable of containing in all near twice as much: this glaſs being hermetically ſealed, the included liquor continued to ſhine, without any external help either of air or heat, for about ſix days and nights, but then it gave over ſhining, nor would be made luminous again by moderate ſhaking.

OBSERVATION VI.

AFTER having poured out ſome more of the liquor and ſediment, that had been kept in the great phial, formerly mentioned, into a ſmaller phial, to make a preſent of it to a virtuoſo, the remaining matter, having now a greater proportion of air included with it, was very apt to be put into a luminous agitation, if I may ſo call it, and would emit exhalations, that would not only fill the cavity of the glaſs, but manifeſtly move to and fro in it after a ſomewhat odd manner. And being one night willing to give a lady, and ſome other company, the divertiſement of a new phænomenon, after having opened the phial, and then having ſtopt it again, I ſhook it, and turned it in ſuch a way, that much the greateſt part of liquor having been before poured out, the reſidence was, as it were, ſpread over the inſide of the glaſs, to which its particles ſtuck, becauſe there wanted liquor enough to waſh them down: by which means, thoſe little portions of the ſediment being not covered, as they were wont to be with water, but expoſed to the immediate contact of the air, ſhone much more vividly than the luminous exhalations were wont to do; and the light being tremulous and twinkling, as well as briſk, they ſeemed to emulate ſo many little ſtars in a cloudleſs but dark night, and continued this ſcintillation longer than one would have expected, to the no ſmall delight of the beholders, for whoſe ſake the experiment was ſeveral times repeated with ſucceſs.

NEW PHÆNOMENA

EXHIBITED by an

ICY NOCTILUCA,

OR,

SOLID SELF-SHINING SUBSTANCE.

SECT. III.

IN the addreſs of the foregoing appendix to the aerial noctiluca, I intimated the reaſon, why I did not think fit to give you a more particular account of the materials I employed in proſecuting my deſign, of making better qualified noctilucas. And therefore I ſhall not for the preſent trouble you with the mention of proceedings, that for want of ſome things, ſeldom procurable, you would not, where you live, be able to imitate; but ſhall ſave you and myſelf the trouble of a further preamble.

HAVING then by proceſſes, not unlike that I annexed to the cloſe of the aerial noctiluca, obtained a ſelf-ſhining ſubſtance of a conſiſtent form; I proceed to give you ſome account of what I have obſerved about it, and tried with it, which will take up the leſs time to do, becauſe many things belonging to it in common with the ſhining liquor, with which I have already entertained you, thoſe will be the fewer, that belong peculiarly to the ſelf-ſhining matter, endowed with a conſiſtent form.

ABOUT which it may be proper to take notice of ſome affections, that ſeem more immediately to belong to the ſubſtance itſelf, than moſt of the things do, that are to follow.

Some qualities of the noctiluca itſelf.

1. And firſt, though it uſually came over in diſtillation in the form of divers little grains or fragments, differing for the moſt part from one another, both in bigneſs (ſome being of the ſize of grains of corn, and others of peaſe, or large cherry-ſtones) and alſo as to their ſhapes, which moſt commonly were irregular, as concretions are wont to be, that are caſually produced; yet when the diſtillation was carried on proſperouſly, we obtained the deſired matter in greater lumps, ſometimes as large as ſmall beans, and ſometimes at leaſt three or four times as large, but not proportionably thick.

2. THESE lumps, whether ſmall or great, were colourleſs, and uſually, when they were held againſt the light, tranſparent; ſo that divers bodies, placed beyond them at a convenient diſtance, might be plainly ſeen through them. And ſome of the bigger appeared ſo like ſuch fragments of ice, as being thin, are oftentimes very clear, and almoſt quite deſtitute of manifeſt bubbles, that, becauſe of this great reſemblance, and for diſtinction ſake, I thought it not amiſs to call our conſiſtent ſelf-ſhining ſubſtance, the icy or glacial noctiluca (and for variety phoſphorus;) which name I choſe to give it, rather than that of chryſtalline, becauſe this epithet is not unfrequently given to every diaphanous liquor, as well as to tranſparent ſolids. But when I ſaid, that our noctiluca was tranſparent and colourleſs, I meant it only in reference to what uſually appeared. For whether it were any real difference in the texture or conſtitution of the body itſelf, or the effect of ſome caſual junctures of circumſtances, I am not ſure; but this occurred to us, that ſometimes, eſpecially by candle-light, ſome leſſer fragments appeared not diaphanous, nor always either colourleſs, nor of the ſame colour. For ſometimes the matter looked reddiſh, ſometimes of a faint, but pleaſing blue, and ſometimes too of a colour to which I cannot eaſily aſſign a known name.

3. OUR icy noctiluca or phoſphorus, is manifeſtly heavier in ſpecie than common water, in which being put, it readily ſinks to the bottom, and quietly lies there.

4. THE ice-like body, though conſiſtent, is not hard, being far leſs ſo, than common ice; but yet it is not ſo ſoft, but that it is brittle, and will more eaſily be broken in pieces by the preſſure of ones fingers, than receive ſhapes from them; and yet by him, that goes ſomewhat warily to work, it may be ſpread upon a ſolid body, almoſt like the unmelted tallow of a candle.

5. THE conſiſtent phoſphorus is fuſible enough. For though in the air it will not be brought to melt, without ſome difficulty and waſte, yet by the help of hot liquors, and even of water itſelf, it may with a little care and dexterity be brought to melt, which is an obſervation of good uſe; becauſe by means of fuſion, ſeveral fragments (if the matter be pure enough) may be brought to run into one lump, and in that condition may both be the better preſerved, and become fit to be applied to ſome conſiderable uſes, which cannot ſo well, if at all, be made of leſſer, though numerous fragments.

6. THIS glacial noctiluca is, as to ſenſe, cold, but of a texture, that diſpoſes it to be eaſily agitated, and by agitation become incaleſcent, as will appear hereafter. When this ſolid noctiluca is held in the free air, though perhaps its ſuperficies be wet, it affords a very vivid light, uſually ſurpaſſing that of the aerial noctiluca; and this light ſeems to proceed from, if not alſo to reſide in, the body itſelf.

7. WHEN our icy phoſphorus is taken out of its receptacle, and expoſed to the immediate contact of the free air, it uſually emits a wonderful deal of ſmoak, diſcernable by the light of the body it aſcends from; and this plentiful emiſſion of effluviums uſually laſts as long as the phoſphorus is kept in the air.

8. BUT it is pleaſant to obſerve, and deſerves to be conſidered, that as ſoon as it is plunged in water, ſo as to be quite covered with that liquor, it ceaſes not only to ſmoak as before, but to ſhine, as if a thoroughly kindled coal were ſuddenly quenched in water. And if it were not for this, our noctiluca would effluviate ſo faſt, that it would be quickly waſted; whereas the water, fencing it from the contact of the air, keeps it from ſpending itſelf as formerly, and yet does really make but a ſeeming and temporary extinction of this anomalous fire. For as ſoon as it is again taken out of the water (though it have lain there perhaps a great while) it falls to ſhine again, even whilſt it is yet dropping wet.

9. AND I have ſometimes had the pleaſure to obſerve, that when I had ſo large a piece of noctiluca, that I could conveniently hold one half of it under the ſurface of the water, and the other half above it, whilſt the immerſed part afforded no light, the extant part ſhone vividly.

HAVING thus mentioned moſt of the qualities, that belong to the noctiluca itſelf, I ſhall now proceed to the phænomena my trials on it, or with it, afforded me, without confining myſelf to any ſollicitous order, ſince my circumſtances permitted me not to keep one in making thoſe trials. But before I deſcend to other particulars, it will not, I think, be amiſs to take notice of a few, that, having more affinity than others with the laſt mentioned quality of our phoſphorus, ſeem proper to be annexed to what has been delivered of it.

OBSERVATIONS
ABOUT THE
WATER
WHEREIN THE
NOCTILUCA was kept.

SECT. IV.

BECAUSE I gueſſed, that the water, wherein the noctiluca had been long kept covered, to fence it from the air, though it did not manifeſtly diſſolve the maſs, yet might be impregnated at leaſt with the more ſaline, and, on that account, reſoluble parts of it, I thought fit to make a few trials upon this liquor.

EXPERIMENT I.

AND firſt, I found, that it had a ſtrong and penetrant taſte, that ſeemed near of kin to that of ſea-ſalt, but was more piercing, as if brine were mingled with ſpirit of ſalt, and it reliſhed alſo ſomewhat of vitriol.

EXPERIMENT II.

BEING put into a ſmall concave veſſel of refined ſilver upon lighted coals and aſhes, it evaporated but very ſlowly, and would not be brought to ſhoot into cryſtals, nor yet to afford a dry ſalt, but coagulated into a ſubſtance, ſometimes like a jelly, and ſometimes, as to conſiſtence, like whites of eggs; which ſubſtance was eaſily melted by heat.

EXPERIMENT III.

WHEN this ſubſtance was kept a while on a hotter fire, it only boiled at firſt, but ſoon after began, as I gueſſed it would, to make a crackling noiſe; wherein this was remarkable and pretty, that the exploſions were accompanied with flaſhes of fire and light, which, if they were ſmall, were generally very blue, like the flames of ſulphur, but more vivid, and ſometimes alſo more blue; but the greater cracks, whoſe noiſe was conſiderable, were wont to appear of a yellow colour and very luminous. And theſe phænomena did not only appear, whilſt the matter was boiling over the fire, but a pretty while after the veſſel was taken off and held in the air.

EXPERIMENT IV.

IF before the coagulated matter were too far waſted by the heat, it were ſuffered to cool a little, it appeared to have acquired a conſiſtence like melted roſin, or rather ſtiff bird-lime, for it would draw out into threads of, perhaps, a foot or more in length; and having held one of theſe threads to the flame of a candle, it did not take fire, but melted into little globules, as capillary threads of glaſs are in like circumſtances wont to do. And having made ſome of them ſtick to the wick of a candle towards the bottom of the flame, they coloured the lower part of the flame quite round with a very fine blue, which laſted much longer than one would have expected.

EXPERIMENT V.

THIS glutinous ſubſtance had, by the action of the fire, acquired an odd kind of ſtrong ſmell, almoſt like that of garlick, and being left all night in the air, attracted to it (to uſe the vulgar phraſe) the moiſture of it exceeding faſt, being diſſolved in a good part into a liquor almoſt as ſtrong as ſpirit of ſalt.

EXPERIMENT VI.

PUTTING this ſubſtance again over the fire, as before, it appeared to be more fixt than one would have looked for; for though there were not ſo much as a ſpoonful of it, yet it continued boiling for a great while, and afforded a multitude of ſhining exploſions, whereof ſome made a conſiderable noiſe, and gave notable flaſhes of light, which ſeemed to be made by condenſed and agitated fumes, ſuppreſſed by the ſomewhat hardned ſurface of the matter, and kindled in their eruption into the air, into which ſome parts of theſe fumes, that were not kindled, eſcaped in the form of a ſmoke, whoſe ſmell was very ſtrong and rank, but of a peculiar kind. To which I ſhall add, what ſeemed ſtrange, that though oftentimes two, and ſometimes more flaſhes appeared at once, yet ſo ſmall a quantity of matter continued to afford them for almoſt an hour together, and probably would have done it longer, but that the late time of the night obliged me to go to bed, before the experiment was finiſhed.

What liquors would, or would not, diſſolve the ICY NOCTILUCA.

SECT. V.

AMong other ways of inveſtigating the nature of our icy phoſphorus, I thought fit to try, whether or no it would be diſſolved in ſome liquors of differing kinds, hoping, that if it would be ſo, in any of them, it might ſomewhat aſſiſt us to gueſs at its texture.

EXPERIMENT I.

WE found then by trial, that common water would not, in the cold, diſſolve it, though the liquor was thereby impregnated; as when *crocus metallorum*, or glaſs of antimony, being infuſed in wine or water, the menſtruum will be impregnated by its emetic particles, and yet the bulk, ſhape and colour of the crocus, or the glaſs, will not thereby be viſibly diminiſhed or altered.

EXPERIMENT II.

AFTERWARDS we put a grain, or two, of our lucid matter into a little urinous ſpirit of ſal armoniac, but it ſeemed not to make any conflict with it, nor manifeſtly to work upon it, though, to give the liquor time to make a ſolution, we left them together for ſeveral days. But, as ſoon as we had poured aſide the ſpirit, it appeared, that it had not, by any contrariety, deſtroyed the power of the noctilula, which began readily to ſhine as formerly, and yet might be immediately ſuppreſſed again, by ſuffering the liquor to cover it as before; but when we had, by keeping the phial, for ſome time, in a moderate heat, impregnated the liquor with it, this liquor, being then dropt into water, had a like effect with that mentioned in the experiment of impregnated ſpirit of wine.

EXPERIMENT III.

SEEING a volatile and urinous ſalt would not work ſenſibly upon our phoſphorus, we thought fit to try, what corroſive liquors would do; and accordingly, we put a grain or two of our ſplendent matter into a very ſmall phial, wherein was a little oil of vitriol, that menſtruum appearing, in many caſes, more corroſive than other vulgar acids: but neither did this menſtruum diſſolve our icy noctiluca in the cold, and therefore putting it in ſome heat, we found, that though it did not manifeſtly diſſolve the ſhining matter, yet the warmed oil made it melt, and appear, at leaſt for the time, a fluid body; in which this ſeemed to be remarkable, that this ſo fugitive a ſubſtance, ſhould be ponderous enough to lye at the bottom of oil of vitriol, which is one of the heavieſt fluids we yet know, except quickſilver, which many will not allow to be a liquor. What we did with this melted noctiluca, was not unpleaſant to ſee, and will, God permitting, be hereafter mentioned.

EXPERIMENT IV.

Afterwards we put a ſmall fragment of our icy phoſphorus into aqua fortis; and though we kept it in that menſtruum two or three days, and ſet the vial, that contained them, for many hours, in a warm place, (the chimney corner) yet we found the matter ſo little altered, as to its viſible appearance, that we doubted, whether the liquor had diſſolved any ſenſible quantity of it.

Having tried ſaline menſtruums upon our icy phoſphorus, I thought fit to try oils, and alſo ſpirit of wine, that is reckoned by chymiſts to be of great affinity with them.

EXPERIMENT V.

Whereupon I put a little of our noctiluca into ſome oil of turpentine, which not diſſolving it in the cold, the ſmall vial, that contained it, was left all night in the chimney, upon warm aſhes. But though, the next day, none of the phoſphorus appeared any longer in the glaſs, yet we could not perceive, by two or three differing trials, that the oil was much altered by it, and particularly I obſerved, that though the glaſs were unſtopt, and kept ſo for a while, yet the ingreſs of the air did not produce any ſenſible light, nor did we perceive the upper part of the glaſs to be full of white fumes, as is uſual in divers other liquors impregnated with our noctiluca, when they are unſtopt.

SECT. VI.

It has rendered the experiments, made with the aerial noctiluca, much leſs acceptable, than otherwiſe they would have been, to the delicate ſort of ſpectators, eſpecially to ladies, that the light they produced was accompanied with a very unpleaſant ſmell, that iſſued out of the phial, whenever it was unſtopped to let in the air. But, by the help of our icy noctiluca, I found a way to prevent this ungrateful concomitant of our artificial light. But, not being diſcouraged by the bad ſucceſs of the forementioned experiment, I hoped an aromatical oil might do, what ſubtil oils had not done.

EXPERIMENT I.

And therefore having, in a very ſmall phial, put about a grain of noctilucal matter, and covered it with as much pure eſſential of cinnamon, as would ſwim leſs than a finger's breadth above it, we carefully ſtopt our little phial, and having warily held the bottom of it againſt a fire, till the phoſphorus began to melt, I ſuffered it to cool; and then unſtopping it in a dark place, had the pleaſure to ſee produced a vaniſhing indeed, but a vivid light. So that by this means, I could afterwards ſhew the production of light to the neareſt perſons of quality, not only without offending their noſes, whilſt their eyes were gratified, but with adding to the pleaſure of a delightful apparition that of a fragrant ſmell. But becauſe oil of cloves is more eaſy to be had good than the oil of cinnamon, and is alſo much cheaper, I tried the experiment more fully with that, and therefore ſhall proceed to give you (for an example of aromatic oils) the phænomena of it.

EXPERIMENT II.

We put ſome of our luminous ice into a little pure oil of cloves, ſuch as the chymiſts call eſſential, but found, after a conſiderable time, (no leſs than ſome days) that at leaſt a good part of the matter was undiſſolved, but yet the liquor was richly impregnated by it, as we found by a pretty phænomenon that it afforded us. For the little phial, it was kept in, being opened in a dark place, there immediately enſued a kind of flaſh of light, far more vivid, its ſmall bulk conſidered, than any liquor had afforded us before. But the brightneſs of this apparition was, it ſeems, too great to be laſting; for this flame-like ſubſtance uſually expired in leſs than a minute of an hour, ſometimes perhaps in half that time. And there were two other circumſtances particular enough in this phænomenon; one, that ſometimes, eſpecially if a candle were in the room, the ſhining fluid would appear of a pleaſant, and ſomewhat ſurprizing blueiſh colour; and the other, that the light would ceaſe, whilſt yet there remained in the upper part of the glaſs, pretty ſtore of whitiſh fumes, ſuch as we have formerly often obſerved in the aerial noctiluca, to be the uſual cauſes, or concomitants of light, as if, in our preſent caſe, the ſhining ſubſtance prey'd on, or reſided in, only the finer and more delicate particles of the whitiſh exhalations.

EXPERIMENT III.

Instead of the oil of cloves, we ſubſtituted ſome chymical oil of mace, into which we put a competent quantity of the glacial phoſphorus: but though we warmed the bottom of the phial, at leaſt as much as we judged neceſſary, yet, upon the unſtopping of it, there appeared no ſign of light, though the trial was made much more than once or twice, and ſometimes with favourable circumſtances; which event was the leſs expected, becauſe the oil, made uſe of, was preſented me as very pure, by the ſame traveller, who gave me that of cloves newly mentioned; and becauſe alſo the warmed phoſphorus was ſo well conditioned, that as ſoon as ever the oil was removed, it ſhone with a ſomewhat extraordinary vividneſs.

EXPERIMENT IV.

We made alſo a trial or two with diſtilled and fragrant oil of aniſeeds, to ſee, if that being an eſſential oil, as chymiſts ſpeak, and being looked upon, by many, as a kind of aromatic oil, it would better diſſolve the noctiluca, or be impregnated by its luciferous parts; but we found, that it neither diſſolved the matter, nor, upon the unſtopping of the phial, that contained it, did it afford any light, or ſo much as whitiſh fumes, which ſeemed ſomewhat ſtrange, becauſe the oil was very ſubtile, and, by its aptneſs to coagulate of itſelf, ſhewed, that it was genuine, and not as chymical oils, that are venal, too frequently (if not moſt commonly) are, ſophiſticated.

IF theſe two laſt recited experiments prove conſtant, they will argue, that not every fragrant, no, nor every aromatical oil, properly ſo called, has the like operation upon our noctilucal matter, as the oil of cloves and cinnamon have.

IF I had had, or could have procured, other eſſential oils, on whoſe genuineneſs I could have depended, I had tried their effects upon our phoſphorus.

EXPERIMENT V.

BUT, having no more oils fit for my turn, I next tried, whether I could diſſolve our ſhining matter in ardent ſpirits, which are thought, by chymiſts, to be of near conſanguinity with diſtilled oils, (not now to enquire, whether they do not conſiſt of the finer parts of the highly rarified oil of bodies, united with a great proportion of their phlegm) and, having accordingly, put ſome of our icy phoſphorus into the ſpirit of wine, though the menſtruum did, ſome hundreds of times, exceed the body it was to work upon, yet after divers days, wherein it ſtood in a window, expoſed to the ſun beams, in the hotteſt part of the ſummer, it appeared undiſſolved, at the bottom of the liquor, and ſcarce ſenſibly diminiſhed. But of the operation of ſpirit of wine upon the noctilucal matter, further trials will require, that more be ſaid hereafter.

Of a way of ſuddenly producing light in common water, by the help of another, not luminous liquor.

SECT. VII.

I COME now to recite to you a phænomenon, which, I preſume, may not diſpleaſe you. I had a hint of it from a caſual obſervation made by my induſtrious laborant. For having, to incourage him, allowed him, for his own uſe, ſome fragments of our icy noctiluca, he mingled a portion of this ſhining ſubſtance with a ſpirituous medicinal liquor, that he had prepared, by extracting ſeveral drugs with it; and having afterwards, upon ſome occaſion or other, diluted it with water, it afforded him a phænomenon, at which being ſurprized, he came to acquaint me with it, bringing me withal ſome of the liquor. But I thinking, that the phænomenon did not depend upon the peculiar nature of the liquor, whoſe being very compounded and high coloured, made me judge it not fit for luciferous experiments, but proceeded from the vinous ſpirits, wherein that liquor abounded, I thought fit to make the experiment with a liquor, as colourleſs and ſimple as I could; the effects of ſuch liquors being more eaſy to be diſcerned, and judged of, and reaſoned upon. And accordingly we weighed out, in a tender balance, one grain of our glacial phoſphorus, wiped dry, and broken in four or five pieces, for the eaſier diſſolution. And to theſe, in a cryſtalline phial, we put a convenient quantity of highly rectified vinous ſpirit, and ſtopping the phial cloſe, we ſuffered the things contained in it to remain for many hours, ſometimes (and indeed for the moſt part) in the cold, and ſometimes in the warm ſun, but perceived not, that near a total diſſolution was made of the noctilucal matter by the liquor, in which it lay, even one of the leſſer fragments appearing, as well as the others, undiſſolved in the bottom of it. However, ſince a body, conſiſting of ſuch ſubtle parts, may communicate many of them to a contiguous liquor, without any diminution of its bulk, obſervable by the eye, I thought fit to try what effects this body had upon the vinous ſpirit.

OBSERVATION I.

AND firſt, I obſerved, that it did not manifeſtly diſcolour the liquor, but left it tranſparent and limpid, as before; ſave that there appeared ſome very ſmall earthy corpuſcles, like duſt, at the bottom of the liquor, when being a little ſhaken, (to raiſe them) it was attentively viewed.

OBSERVATION II.

WE did not obſerve, that, upon the unſtopping of the phial, and the reſtored commerce between the inward and outward air, there appeared any flame or luminous exhalations, as is uſual upon opening phials, that contain the liquid aerial noctiluca.

OBSERVATION III.

BUT the phænomenon I chiefly intended to relate was this, that, having in a dark night, dropt a little of this impregnated ſpirit into a ſmall china cup, with common water in it, though the ſpirit, neither in the phial, nor in its paſſage through the air, diſcloſed any degree of luminouſneſs, yet, as ſoon as ever the drops came to touch the liquor, they would be, as it were, kindled by the cold water, and afford little flaſhes of light, which was more vivid than the noctiluca itſelf, affording a ſplendor, that made not only the brims of the cup, but divers of the neighbouring objects manifeſtly viſible, not to ſay conſpicuous. But theſe coruſcations had the property of other lightning, to vaniſh almoſt as ſoon as they appeared, nor would the water that produced them, by being agitated, ſhine; but others might immediately be produced, by letting freſh drops fall into the ſame water, upon whoſe ſurface they ſeemed to diffuſe themſelves, and would ſometimes leave, for a little while, a faintly luminous, as it were, film or membrane.

OBSERVATION IV.

AND that it might not be thought, that this acceſion (if I may ſo call it) was produced, or occaſioned, by any antiperiſtaſis, which the ſchool-men, and the generality, even of philoſophers, are pleaſed to fancy (whoſe opinion I have, in a particular diſcourſe, examined) I thought fit to try, whether our phænomenon would not be produced with hot water, as well as with cold; and accordingly I found, that the impregnated ſpirit of wine produced rather a greater than a leſſer light, in hot water, than it had done in cold.

ONE of my deſigns, I had in making this experiment, being to examine a conjecture I had made about the great diffuſedneſs of the noctilucal matter, the ſubtilty of whoſe particles made me think they were not to be judged abſent, where-ever they were not numerous, or agitated enough, to be of themſelves viſible: this, I ſay, being in my thoughts, I judged it not fit to put our ſplendent icy matter into the ſpirit of wine, at adventures. Wherefore, having in a very good balance weighed out one grain of our noctiluca, (firſt wiped dry) we put to it, at ſeveral times, that it might the better diſſolve, about two thouſand grains of ſpirit of wine, that would burn all away; and yet, which may ſeem ſtrange, this ſmall quantity of noctilucal matter did ſo impregnate all the liquor put upon it, that though nothing of luminous did appear in the menſtruum, nor in any exhalations riſing from it, though the phial were unſtopped, or the liquor poured out of it into the air; yet, as ſoon as ever it was dropt into common water, there would be produced a vivid apparition of light, ſuch as has been a little above deſcribed.

IT ſeemed not very improbable, that theſe ſudden and vaniſhing flaſhes might, at leaſt in great part, proceed from the quick diſengagement and extruſion of the noctilucal particles, made by the water, which, diluting the vinous ſpirit, diſabled them from retaining with them the luciferous corpuſcles. As if into one ounce of high rectified ſpirit of wine, you put half a dram or a dram of camphire, the liquor will diſſolve it, without being thereby manifeſtly altered, as to colour or tranſparency; but if you drop this ſolution into common water, the vinous ſpirits will immediately diffuſe themſelves into the liquor, and let go the corpuſcles of the camphire, which will float like a white powder upon the ſurface of the water. To this conjecture is agreeable, what, upon trial, we obſerved with our impregnated ſpirit of wine, namely, that being dropt into other, well deflegmed ſpirit of wine, we ſaw no light produced; but when it was dropt into an urinous ſpirit of ſal armoniac, which ſeems to conſiſt of the volatile ſalt diſſolved in the phlegm or aqueous liquor, the noctilucal corpuſcles by this wateriſh part were freed from the vinous ſpirits, almoſt as much as they would have been by common water, and did accordingly ſhine with much briſkneſs.

EXPERIMENTS
Diſcovering a ſtrange
SUBTILTY of PARTS
IN THE
GLACIAL NOCTILUCA.

SECT. VIII.

BUT what has been above recited, is not all that I thought fit to try with the ſhining matter, that I told you we diſſolved in ſpirit of wine; for after having, as I lately recited, brought one grain to impregnate between four and five ounces of alcohol, as the chymiſts call the high rectified ſpirit of wine, which did at leaſt two thouſand times exceed the weight of the noctilucal matter, I preſumed, that this very parcel of ſpirit of wine, wherein the ſhining matter was already diffuſed and ſcattered into ſo many thouſand corpuſcles, as ſufficed to impregnate all the liquor, would yet communicate to a good quantity of water particles enough to make it ſhine, when agitated: wherefore when we had weighed out in a very truſty balance one dram of our impregnated ſpirit of wine, we mixed it with, and ſhook it in as much ſpin water as we thought fit, (but not all at once) that is, till we had to our dram of ſpirit of wine put above fifty times its weight of water; and that alcohol itſelf weighing at leaſt two thouſand times as much as the noctilucal matter, that impregnated it, it follows, (though it may ſeem ſtrange it ſhould be true,) that the ſingle grain of icy noctiluca was able to diffuſe itſelf through, and impregnate full a hundred thouſand grains of liquor, ſo as (when duly ordered) to make it luminous. For having preſently after the laſt water was put into the glaſs, ſtopt the veſſel cloſe with a good cork, and ſhaken it a little in a dark place, the whole vial appeared to be full of light, which though it were not more than ordinary intenſe, yet, by reaſon of the bulk of the liquor, made a glorious ſhew, and diſcovered divers of the neighbouring objects. And after we had done ſhaking that vial, not only the upper part, which was filled with exhalations and vapours, ſhined like thoſe other liquid phoſphoruſſes formerly mentioned, but what was not obſerved in them, the water itſelf had a luminouſneſs, though of an inferior degree, of its whole maſs; which yet will not keep me from thinking of ſome expedient, that may ſatisfy thoſe, who may ſuſpect, as I did, that ſome of this light proceeded from the exhalations, that ſhined through that diaphanous water, though this did not ſeem the only, nor perhaps the chief cauſe of its appearing luminous, ſince when the glaſs was ſhaken, the whole maſs of the liquor appeared to ſhine, ſo that we could plainly ſee through the ſides of the veſſel the conical figure of its bottom.

AFTER this, I proſecuted the experiment a good way further, increaſing the proportion of the water to freſh impregnated ſpirit; and I found (what perhaps you will think ſtrange) that one part of the noctiluca, being firſt diſſolved in alcohol of wine, and afterwards briſkly ſhaken into a convenient quantity of water, rendered luminous as much liquor as upon calculation amounted to four hundred thouſand times its weight. And this did not ſeem to proceed from the irradiation of the luminous corpuſcles or exhalations, ſhining in the empty ſpace at the top of the glaſs, becauſe the vial was ſo near filled with liquor, that there was but little room left for vapours; and becauſe alſo the vapours, that did play in that ſpace, ſhined but very faintly, and when the glaſs was at reſt much leſs than a minute of an hour, the light would reach but a little way downwards in the water, and yet was there ſo dim, as to be ſcarce diſcernable. Whereas in our experiment, not only the agitated liquor appeared luminous throughout, but the light was briſk enough, inſomuch that the conical figure of the bottom of the glaſs was clearly viſible by the help of it.

LASTLY, leſt ſome ſhould think, that if this experiment had been further and further proſecuted, the luminouſneſs would have ſtill extended to greater and greater quantities of water, I ſhall add, that when I increaſed the proportion of this liquor to the noctilucal matter, to be diſperſed through it, by putting in near three or four ounces of water more than I gueſſed would be convenient, the luminous matter ſeemed to be, as it were, drowned or loſt in ſo much liquor; for though we gave it much more agitation, than had in the former experiments been needful to produce light, yet no luminouſneſs at all appeared in the mixture. Wherefore, taking ſome freſh ſpirit, and ſhaking it into ſuch a quantity of water as I thought it might ſerve to impregnate, I found by ſupputation, that the luminous maſs of liquor, thereby produced, amounted to no leſs, but a pretty deal more, than five hundred thouſand times the weight of the noctilucal matter diſperſed through it, which is a viſible expanſion, very much greater, than, I think, has been hitherto obſerved in any corporeal ſubſtance diſſolved in a viſible liquor, ſince it four times exceeds that expanſion of cochineal, which I many years ſince imparted to the ingenious, and which ſeveral of them have in their writings, been pleaſed to take notice of, as a prodigious thing; one part of the cochineal, ordered as I there mention, having in that experiment produced a diſcernable colour in an hundred twenty five thouſand parts of water. To what has been ſaid I ſhall add theſe three circumſtances, which may increaſe the ſtrangeneſs of the experiment.

1. THE firſt is, that I here only delivered the manifeſt impregnation of the water itſelf, which is a groſs and tangible liquor, by the diſperſed particles of the noctilucal matter, but have made no eſtimate of the incomparably greater expanſion of the light, that, from the matter included in the vial, illuminated the ambient air, to a conſiderable diſtance from it, though, by reaſon the darkened room was not great, I was diſabled to make an eſtimate, how far the enlightened ſphere of air might have extended.

2. THE ſecond is, that this experiment was not favourably made, but rather invidiouſly, ſince we purpoſely weighed out ſomewhat leſs of the lucid matter, and now and then more of the water, than the preciſe quantities that calculation ſuppoſes, that I might be ſure the experiment was made ſeverely enough.

3. AND laſtly, upon ſearch I found, that the grain of icy phoſphorus, that was firſt put into the ſpirit of wine, we made uſe of all this while, was not, though after ſo long a time, totally diſſolved; a ſmall fragment, amounting to about an eighth part, if not more, remaining at the bottom of the vial; upon which having poured ſome freſh al-

cohol of wine, and kept it a while in a little heat, to further the diſſolution, I found that liquor did, as I thought it would, grow very luminous, when dropt into common water; ſo that it ſeemed probable, that if the whole grain of icy phoſphorus had been diſſolved at firſt in the ſpirit of wine, it would have impregnated above ſix hundred thouſand times its weight of water, ſufficient to make it ſhine.

SECT. IX.

I COME now to another way, by which I thought the great ſubtilty of parts in our noctilucal matter might appear with good advantage, and poſſibly you will think by the ſucceſs, that I miſſed not of what I expected from the intended trial.

EXPERIMENT I.

WE carefully weighed out a ſmall lump of our ſhining matter, amounting to three grains, and having purpoſely broken it into divers leſſer fragments, perhaps ſix or ſeven at leaſt, we laid them upon a flat bottomed glaſs, that was broader at the top than the bottom, and ſhallow too, (not being near an inch deep) that the matter might be more fully expoſed to the free air. This glaſs we placed in a ſouth window, laying it very ſhelving, that the liquor to be produced by its reſolution in the moiſt air might preſently run down, and not hinder the free evaporation of the remaining matter. In which poſture of the glaſs, we had alſo another aim, to be hereafter mentioned. The veſſel being thus placed, about ten of the clock at night, all the fragments of the noctiluca ſhined briſkly, and ſo continued to do, till moſt of them were reſolved into other ſubſtances, and the biggeſt of them continued to ſhine, till they were reduced to ſuch a ſmallneſs, that they would ſcarce have been ſeen, had not their own light made them viſible. But the main thing, that I am to take notice of in this experiment, (and which perhaps will ſomewhat ſurprize you,) is, that ſo little quantity of noctilucal matter continued to emit viſible fumes for a good many more than an hundred and fifty hours, and this with circumſtances, that made the thing more ſtrange.

1. AS firſt, that this ſmoke was not only viſible but manifeſt, and that as well in the night (as I often obſerved from time to time) as in the day.

2. SECONDLY, that the ſeveral parcels of matter did each emit theſe fumes all at once, as if it were from ſo many little chimneys.

3. THIRDLY, that this ſmoke was ſo copious, and withal ſo tenacious, that it would eaſily retain the form of ſmoke at a conſiderable diſtance from the bodies that emitted it; ſo that, as I walked to and fro in the room, a careleſs look towards the glaſs would often diſcover it to me, and ſometimes it would manifeſtly appear at a diſtance, that I eſtimated to be near a foot from the matter that afforded it.

I SHALL now add, to another purpoſe, the following circumſtances; namely,

1. FIRST, that the motion of the ſmoke was ſwift enough, conſidering that it had no channel or chimney to aſſiſt it. It was not always, nor for the moſt part, directly upwards, but ſometimes horizontal, ſometimes downwards, ſometimes towards the right hand, and ſometimes towards the left, as if the motion of the fumes had been determined by the ſituation of thoſe parts of the noctilucal fragment, by which they were emitted, and as it were diſcharged. I uſe this laſt expreſſion, becauſe taking pleaſure to watch attentively the circumſtances of our delightful experiment, I thought, I many times obſerved a kind of palpitation or æſtuation in the little ſhining fragments, which I gathered from the apparent great inequality I perceived in the plenty of the ſmoke, that was emitted at ſeveral times, all of them perhaps within the compaſs of a minute or two. But on this I forbear to diſcourſe, till I ſhall have made further obſervations; and therefore I ſhall proceed to take notice of one circumſtance more in our experiment; which is,

2. SECONDLY, that even in the latter part of it, after the ſhining matter had been ſo long expoſed to the air, it emitted a ſmell ſtrong enough; which ſeemed to be cauſed by odorous exhalations, diſtinct from the viſible fumes.

SECT. X.

AND now it is time, that I give you ſome account of the reaſon, (that I but pointed at before,) why I choſe ſuch a glaſs, and kept it in a ſhelving poſture: this I did, that I might not loſe, but preſerve the liquor, which I knew would fall from the ſaline part of the ſhining matter, which liquor I thought fit to examine, in order to diſcover certain things; particularly, whether the limpid water, as it appeared to be, that was, as it were, the cadaver, or, to employ chymical terms, the deliquated *Caput Mortuum* of the ſhining ſubſtance did not yet contain ſomething, as well luminous as ſaline.

EXPERIMENT I.

TO ſatisfy myſelf about this, I cauſed this liquor to be put into a ſmall concave veſſel of carefully refined ſilver, (that other ſalts than nitre and allum might not corrode it) which I had purpoſely provided for the quick evaporation and cryſtallization of ſmaller quantities of matter. Our liquor, being in this veſſel put upon ſome ſmall coals and aſhes, did not evaporate near ſo eaſily, as one would have thought, but turned into an unctuous ſubſtance of a dark reddiſh colour: wherefore we placed the veſſel upon quick coals, that by their briſk heat they might make the liquor boil, and free it from ſuperfluous moiſture. By this means, after a while, it was reduced to a ſubſtance, that afforded us a pretty phænomena, not unlike to that elſewhere mentioned, where we ſpake of the infuſion or ſolution of the ſolid phoſphorus in common water. For the boiling liquor crackled like a handful of bay-ſalt caſt into the fire; and whilſt theſe cracklings continued, (which they did much longer than one would have expected) they imitated little volleys of ſhot, not only in the great number of the noiſes they made, but in the little flaſhes that accompanied them; which flaſhes, when the fire was ſomewhat increaſed, were ſo many, and followed one another ſo faſt, that they appeared to make up a continued flame, not unpleaſant to behold.

EXPERIMENT II.

AFTER the foregoing experiment, I had a mind to be able to make ſome eſtimate, how far the breaking of the ſhining matter into fragments, and the conditions of the veſſel contributed to the quick conſumption of it. To this purpoſe, we took a lump of three grains, carefully weighed out, and put it into a ſmall glaſs funnel, whoſe upper end was wide and capacious enough, in reference to the lower part, which was exceeding ſlender, that the noctiluca might have air both above and (oftentimes) below, and yet the matter might not ſlide down, till it were ſo waſted as to be leſs than a ſmall pin's head. A veſſel of this ſhape I choſe to make uſe of, that I might catch the liquor, that would be afforded by the deliquation of our icy phoſphorus; for which purpoſe, the ſlender pipe of this funnel was put into the orifice of a ſmall cylindrical vial, and there kept in a quiet place, which was a ſouth window, from whence every night, after I was in bed, I cauſed it to be brought into my chamber, to ſee if it continued to ſhine. By which trials I found, that it remained luminous, and was not yet ſo waſted, to fall quite through the funnel into the vial, at ſomewhat beyond the end of the fifteenth day; ſo that it continued to ſhine three hundred and ſixty hours.

THE very limpid liquor, that was brought into the vial by this experiment, was unhappily loſt before I could make any trials with it, but not before I had done the chief thing I aimed at, in ſaving of it, which was to know its weight to be by and by mentioned.

WHAT has been hitherto related may juſtly enough make a man reflect, with ſome wonder, upon the ſtrange minuteneſs and multitude of parts, that are crouded together in our noctilucal matter; if we conſider what a multitude of luminous beams of viſible ſmoke, of odorable, though unſeen, effluviums ſo ſmall a quantity of it, as three grains, which are but the twentieth part of a drachm, could inceſſantly afford for two or three hundred hours; leaving, after all this, behind it above three times its weight, (for ſo we found it to be) of a liquor, which itſelf was not a cadaverous one, or, what it looked like, common water, but (as may be argued from what was lately recited of the ſame kind of liquor) might have been impregnated with very many ſaline parts, and not a few capable of ſhining briſkly.

OBSERVATIONS
ABOUT THE
INFLAMABILITY
OF THE
NOCTILUCA itſelf.

SECT. XI.

OBSERVATION I.

I TOOK a little of the conſiſtent noctiluca, and having broken it, and, as its brittleneſs would permit, ſpread it here and there, upon a piece of folded paper, I lighted that paper at the flame of a candle, and obſerved, that when the flame reached this or that little fragment of the ſhining matter, it would take fire, and burn away in a flaſhing and very ſputtering manner, accompanied with noiſe, almoſt as grains of ſalt-petre are wont to do, when they are put upon a live coal.

OBSERVATION II.

I OBSERVED alſo, that if I put pieces of paper, on which I had placed ſome of theſe grains of noctilucal matter, upon ſome embers covered with aſhes, before the paper itſelf took fire, the ſhining matter would communicate its flame to the contiguous paper.

EXPERIMENT I.

WE took a fragment of our ſhining matter, not amounting to a grain: this we put into half a ſpoonful or leſs of high rectified ſpirit of wine, and kindling that liquor with the flame of a candle, the ſpirit burned away, as is uſual, in a flame partly yellow, (and eſpecially at the outſide) but chiefly blue. But though the heat of the ſilver ſpoon, wherein the trial was made, did quickly (as might well be expected) melt the noctilucal matter, and gave it a globular form, yet it continued at the bottom without manifeſtly mixing with the vinous ſpirits, or conſiderably altering the colour of their flame: but when the ſpirit of wine was all conſumed, without leaving any jot of phlegm behind it, the laſt drops coming, when they were actually kindled, to touch the ſhining matter, preſently ſet it a fire, but its flame was very differing from that of the vinous ſpirits. For beſides ſomewhat, that was odd in its figure, its colour was not at all blue, or bluiſh, but of an intenſe yellow, and burned ſo fiercely, and with ſo vivid a light, as was ſomewhat ſurpriſing to behold, and continued to burn a pretty while, conſidering the paucity of the combuſtible matter. And whilſt it burned it emitted good ſtore of ſmoke, that ſeemed to be darted up to a conſiderable height. The matter did not burn all away at firſt, but left a kind of *Caput Mortuum,* which lay in the form of a little cake, partly of a deep yellow, and partly of a fine red. This matter being more bulky in proportion to that, that was conſumed, than I thought it likely that ſo little of the phoſphorus ſhould contain of incombuſtible matter; I proceeded to burn it, as elſewhere will be related after another manner, till there remained but ſome very few light feces, that ſeemed to be of the ſame nature with thoſe, that are to be mentioned in the next experiment.

EXPERIMENT II.

WE took a ſmall fragment, not amounting to a grain of the noctilucal matter, and putting it into a ſilver ſpoon, we caſt upon it the ſun beams concentrated by our ſmalleſt (dioptrical) burning glaſs: by theſe it was preſently ſet on fire, and afforded, together with a great deal of ſmoke, a flame exceeding yellow, and ſo very fierce and bright, that it was conſpicuous, though the window being purpoſely ſet open, the beams of the ſun, then in the meridian, were ſuffered to beat full upon it, and a briſk wind did alſo blow upon it without extinguiſhing it. At the bottom of the ſpoon, the expiring flame left a round and broad *Caput Mortuum,* conſiſting of divers circles, like thoſe of a ſardonix, whereof the largeſt was white, another yellow, and the third red, all the three colours being pleaſant and vivid enough. Some part of this *Caput Mortuum,* being again brought to be freely touched by the air, appeared combuſtible, and the reſt being left in the ſpoon, that the air might work upon it, did for the moſt part ſoon reſolve itſelf *per deliquium* into a liquor, almoſt as ſharp as ſpirit of ſalt, the reſt being a light black feculency, of which, becauſe there was ſo very little of it, we could make no examen.

EXPERIMENT III.

BEING deſirous to try, whether the noctilucal matter would, by bare preſſure or motion, be brought to burn, I thought not fit to depend upon ſuch other experiments, as are here related, wherein it appears able to ſet fire on divers bodies, belonging to the vegetable kingdom, or are otherwiſe eaſily inflamable: wherefore we put two grains of our dried noctilucal matter into a glaſs mortar (furniſhed with a glaſs peſtle) whoſe coldneſs and thickneſs were able to keep it from being put into any ſenſible heat by the operation, that was to be performed in it, and conſequently from communicating any heat of its own to the noctilucal matter. This was pretty briſkly rubbed in the mortar, with the glaſs peſtle; but though it was thereby brought to ſhine much more vividly than before, yet it did not take fire; which I was apt to impute to the great coldneſs of the glaſs, which much oppoſed the incaleſcence of the phoſphorus; but after a while longer it took fire, and began to burn away in an actual flame, with much ſmoke: but this did not laſt ſo long, as might have been expected, which ſhort duration might proceed from the veſſel, that continued ſenſibly cold, and perhaps alſo from the narrowneſs and depth of it, which ſomewhat hindred the free acceſs of the air; for ſome matter, that was taken out on the peſtle, ſeemed to burn better, than that which remained in the mortar, which being extinguiſhed, was once more kindled by trituration, but ſoon expiring again, could not by the ſame means be rekindled, but only was brought to ſhine briſkly.

EXPERIMENTS
About BURNING other
BODIES
WITH THE
NOCTILUCA.

SECT. XII.

I Formerly intimated, that our conſiſtent noctiluca, notwithſtanding the appearance it had of ice, and its actual coldneſs to the touch, was much diſpoſed to have its parts eaſily put into motion, and might by that means be brought to be ſenſibly hot. And I think it time now to proceed to make this good by particular inſtances.

1. And firſt, if our phoſphorus be for any time preſſed hard between ones fingers, or againſt a board, or ſome ſuch hard and not very cold body, it will oftentimes be felt actually and very ſenſibly hot, and ſometimes the degree of heat will be ſo vehement as to ſcorch the ſkin, as my venturous laborant found ſeveral times, to his no ſmall pain, his fingers being almoſt covered with bliſters raiſed on them, by handling our ſhining matter with too bold a curioſity; and he complained to me, that, though according to the uſual fate of chymiſts, he had been often burned on other occaſions, yet he found bliſters, excited by the phoſphorus, more painful than others; and he is not the only perſon, that has complained to me of their finding the burning made with this matter to be more tedious and difficult to be cured, than ordinary ones. But, as our noctiluca was not always made of the ſame matter, nor with care equally ſucceſsful, ſo I obſerved its proneneſs to incaleſcence, and the degrees of heat, to which it would be brought by motion, to be differing enough; upon which account, I did not find, that ſome portions of it would produce thoſe higher effects of heat, that ſome others did, beſides that theſe higher effects did gradually differ among themſelves.

2. Agreeably to this, after having in vain tried to fire paper by preſſing and rubbing ſome of our phoſphorus upon it with the blade of a knife, I took a piece of fine paper, and having dried and warmed it at the fire, I put a little of our noctiluca in a fold of it, and rubbing the paper between my hands, though by that attrition there were produced a ſenſible, and even conſiderable heat, yet it did not reach to what I deſired; but continuing a little while to rub the paper to and fro, it did on a ſudden take fire, and blazed out, ſo that it would have burned my hand, if this had not been kept from receiving much harm (for all it did not eſcape) by a thin glove, that was thereby ſcorched, and in part ſhrivelled up. After the ſame manner, to make the experiment the more certain, I fired another piece of paper, but then deſiſted, that I might not unneceſſarily waſte a ſubſtance, wherewith I was but meanly ſtored.

3. If the firing of gun-powder could be performed with our phoſphorus, without the aſſiſtance of circumſtances, whoſe difficult concourſe will keep it from being more than an inſtructive curioſity; the fear, that it might be applied to uſes miſchievous to men, would keep me ſilent of the power our phoſphorus may be brought to have of kindling gun-powder, when it is befriended with favourable circumſtances. To try therefore, whether our phoſphorus, which appeared not inferior to that of Mr. *Craft's*, would (as his did ſometimes, though not eaſily) fire gunpowder, we took a little of our ſhining matter, and having a little wiped it, to dry it, we put it upon ſome dry gun-powder, and with a knife preſſed it, and in ſome ſort rubbed it upon the black grains, but found, that though a heat were produced, and ſometimes ſuch as would make ſome of the corns of powder have a bluiſh flame, yet the mixture would not go off; ſo that the laborant, to whom I left the care of reiterating the experiment in my preſence, preſuming it would not ſucceed, ſcrupled not to hold his head over it, that he might the better ſee what change was made in the mixture; but then upon a ſudden the powder took fire, and the flame ſhooting up, caught hold of his hair, which made a blaze, that proving innocent enough, became more diverting than the ſmell of the ſmoke, that ſucceeded it, was delightful.

4. But the ſame laborant, who was very helpful to me in varying the preparation of the phoſphorus, had a worſe miſadventure not long after; for bringing me ſome newly diſtilled grains of our noctiluca, covered with ſome of the ſhining water, that came over with it, he unluckily broke the glaſs in his pocket; whereupon the heat of his body, in-

creaſed by the motion his long walk had put it into, did ſo excite the matter, that was fallen out of the broken vial, that it burned two or three great holes in his breeches, before he could come to me to relate his miſfortune, the recent effects of which I could not look upon without ſome wonder as well as ſmiles.

5. HAVING already told you the effect of our noctiluca upon gun-powder; I thought fit to try, whether it would not kindle a body, that is thought ſomewhat leſs prone to take fire. And accordingly having put together about half a grain of our dry noctilucal matter, and ſix times its weight of common flowers of ſulphur, they were lodged in the fold of a piece of white paper, which was laid upon a board, and when I had a little bruiſed and rubbed this with the haft of a knife, it ſhone through the intercepted paper very vividly, but did no more: wherefore ſuſpecting, that the want of air was the cauſe why it did but ſhine, not burn too, I opened the paper, and found, that as ſoon as the air had acceſs, it took fire and furiouſly burned the paper, and, if I had not been wary, had burned me too. Another time, the ſame experiment being tried, afforded this notable phænomenon, that the ingredients, being well rubbed together in folded paper, though before the paper was diſplaid and expoſed to the air, they did not kindle, yet upon the contact of this the mixture took fire, and did not burn away with a ſlow flame, as brimſtone is wont to do, but flaſhed away at once with a great blaze, like fired gun-powder, ſave that the flame appeared more luminous.

6. THE higheſt effect of the heat of our icy noctiluca was caſually produced by the laborant, who being deſirous to try, whether ſome that was newly prepared was good and fit to be brought to me, began to write letters with it upon a piece of plank, that had been long uſed in the laboratory as part of a ſtove; and he, chancing to preſs the recent matter hard upon this board, that the conſtant heat of the place had brought to an unuſual degree of dryneſs, found to his ſurprize, that he had not only ſhining but burning letters; the lucid matter having actually ſet on fire thoſe parts of the wood, againſt which he had ſtrongly preſſed it.

SECT. XIII.

EXPERIMENT I.

TO examine ſomewhat particularly, to what family, or ſort of ſalts, the ſaline part of our noctilucal matter either does belong, or has moſt cognation with (for I thought it poſſible it might not fully agree with any known ſpecies of ſalts, but have ſomewhat peculiar to itſelf) I ſuffered a little of the ſmall ſtock, I then had, to reſolve itſelf *per deliquium* into a clear liquor, and then made with it ſome of the trials elſewhere delivered, by which I am wont to examine what ſpecies a ſalt belongs to, gueſſing this liquor by the taſte, and the manner how it was made to be ſomewhat, though not altogether, of the nature of ſpirit of ſea-ſalt: I dropt a little of it upon a convenient proportion of ſyrup of violets, and found, that it turned it not green, as a volatile urinous ſalt would have done, but of a fine carnation colour, ſuch as that ſyrup is wont to acquire, upon the mixture of an acid ſpirit with it. I found alſo, that a very little of our anomalous liquor preſently deſtroyed the blue colour, and not the other of a tincture of *Lignum Nephriticum*.

EXPERIMENT II.

I ALSO put ſome of this liquor, that came by deliquium from the noctiluca, upon ſome filings of copper, which being thoroughly wetted, and ſome of them covered with it, I expoſed in a hollow glaſs for two or three days to the air; and by this means had, as I expected, without the help of heat, a ſolution of ſome of the filings of copper, the colour of which was not a deep azure, as if it had been made with a volatile urinous ſalt; but ſeemed to partake of green and blue, and to be an intermediate or compounded colour.

EXPERIMENT III.

TO make the ſaline nature of this liquor the more manifeſt, I put ſome of it upon powder of red coral, which it preſently fell upon, and corroded with noiſe and froth; and putting another parcel of the ſame liquor upon ſome dry ſalt of tartar, there preſently enſued a fierce conflict between them, whereby ſome noiſe and much froth was produced; ſo that I thought it needleſs to waſte any more of the noctilucal matter, (wherewith I was but ſlenderly ſtored) to make it more apparent, that our liquor was not, as moſt chymiſts would have expected, of an urinous nature, but belonged to the family of acid ſalts, and ſeemed to be near of kin to that branch of them, to which the ſpirituous part of common or ſea-ſalt belongs.

EXPERIMENT IV.

SOME virtuoſi may be apt to think, that ſince our icy noctiluca is of a more ſolid ſubſtance than the aerial, and uſes to continue to ſhine much longer; ſince, I ſay, this is ſo, if the conſiſtent phoſphorus were included in a glaſs, whence its expirations could have no vent, the matter being kept from waſting, the luminouſneſs may alſo be kept from ceaſing. This conjecture being plauſible, though the notion I have of the nature of our noctiluca could not promiſe me a confirmation of the conjecture, yet, to prevent the being blamed for an eaſily evitable omiſſion, I put ſome of our dry phoſphorus into a clear vial, capable, as was gueſſed, to hold about an ounce of water, and having very carefully cloſed this glaſs, I laid it aſide, and obſerved it to continue to ſhine for ſome few days; after which the light manifeſtly decayed, and ſoon after quite diſappeared, though I thought it poſſible, that it did not altogether ſo ſoon expire, as it ceaſed to be viſible to me; becauſe the whitiſh fumes, emitted by the matter while it continued to ſhine, had covered the inſide of the glaſs with a kind of whitiſh ſoot, that, at length opacating it, might well hinder a faint light from pervading the veſſel, and reaching our eyes. But it ſeems, that the air included with the phoſphorus, either had ſome vital ſubſtance (if I may ſo call it) preyed upon thereby, or elſe was by the fumes of the phoſphorus, to name no other poſſible ways, tamed and rendered at length unfit to continue the flame [*ſui generis*] of our noctiluca.

EXPERIMENT V.

YET to purſue the deſign of making a light more laſting than ordinary, by keeping the matter from commerce with the external air, I took ſome of our noctilucal matter, that came over with the aqueous, from which it was not ſo eaſily ſeparable, but that I thought it beſt to leave them together, in regard that it ſhone ſo well, that it might paſs for an excellent portion of the aerial noctiluca: this we ſealed up in a glaſs egg (whoſe bottom had been made flat on purpoſe, that it might ſtand without leaning) and ſetting it in a place, where it would be frequently in my eyes, I obſerved it from time to time, eſpecially at night, and found it continue to ſhine (if I much miſremember not) a week or longer, and that with ſo little decay of light, that I was ſurprized, when, coming in the night time to look upon it, I found it to ſhine no more at all, eſpecially ſince I could not reſtore any manifeſt light to it, either by agitation, or by moderately warming the ſealed glaſs, that contained it.

EXPERIMENT VI.

AFTER many obſervations made of the degrees of light, that our icy noctiluca afforded, as it were of its own accord, without external heat, I thought fit to try, whether by the application of a moderate heat of the fire, the light might not be much invigorated, and perhaps the phoſphorus itſelf be brought actually to kindle, even in a cloſe veſſel. This deſign I was the rather induced to proſecute, becauſe I had ſome hopes, that by this way of increaſing the light of our phoſphorus, though it ſhould not long retain its acquired degree of luminouſneſs, yet this increaſe might continue long enough for ſome not inconſiderable uſes. And eſpecially (in caſe much noctilucal matter were heated at once) to give light enough for taking of gun-powder out of the gun-room of a ſhip, or out of a magazine, without danger of firing the powder, which would be a means to prevent thoſe ſad accidents, that have but too frequently happened to ſhips, eſpecially of war, of which we had very lately a notable inſtance in the river of *Thames*. In proſecution of this deſign, we took ſome grains of our conſiſtent phoſphorus, and having put them into a round glaſs egg, ſomewhat larger than an ordinary hen egg, fitted with a ſtem of a proportionable bigneſs, and about two thirds of a foot long. This being hermetically ſealed up, (at leaſt as far as we diſcerned) the globulous part of it was warily and by degrees warmed at the fire, and then we inſtantly removed it into a dark place, where the included matter not only ſhone by great odds more vividly than before it was heated, but ſome portions of it were brought to an actual flame, as appeared both by the radiant ſplendor of the burning matter, and by the condition of the ſmoke it emitted; and yet more manifeſtly, by the intenſe heat, which the flaming part of the matter (and not the other parts) communicated to that part of the glaſs, which it adhered to; for there the veſſel was not to be ſo much as touched without inconvenience: and when this flame expired, which it did after no long time, the portion of the lately kindled matter did no more ſhine or burn as before, but was reduced to the condition of the reſt of the noctilucal matter, together with which it did for a good while retain a conſiderable degree of light, upon the account of the heat it had been expoſed to, over and above that luminouſneſs, that ordinarily belonged to it.

THIS experiment appeared ſo ſtrange, and was ſo delightful to thoſe, that had never ſeen it, that partly to gratify the curious, and partly to purſue my own deſign, it was reiterated, within the compaſs of a month or two, between (if I miſtake not) twenty and thirty times, the ſame matter being ſtill kept in the ſame veſſel, though by being melted, and in great part ſublimed by its frequent approaches to the fire, it was divided into ſeveral parcels. But this made the experiment ſo much the more pleaſant, in regard, that ſometimes (for it was not always) more than one or perhaps than two portions of the matter would ſeem to burn at once. This was looked upon as a very new and ſcarce credible thing, that one ſhould be able to bring a body to burn with an actual flame, and for no inconſiderable time, in a glaſs hermetically ſealed, and not large neither. But to deal with philoſophical ſincerity, I muſt not conceal from you, that after we had made many trials in the abovementioned glaſs, there happened a phænomenon, which gave me ſome ſuſpicion, that at that time it was not actually ſealed: but it did not appear, but that it had been very well ſealed at firſt, and might continue ſo during ſeveral trials; for after this ſuſpicion we uſed this glaſs ten or twelve times, or perhaps oftner, to make the before recited experiment, and after all thoſe we could perceive no crack or flaw at all in the ball or ſtem of the glaſs, and found it difficult to get in the point of a ſmall pin into a little hole, which we either found, or, by endeavouring to find one, made at the apex. However, by the things formerly related, it appeared, that our noctilucal matter would burn with leſs vent by great odds, than other fewels known to us; and that a ſmall quantity may be made to burn and ſhine longer, than one would expect. And we were encouraged by what we ſaw, to hope, that if a more conſiderable quantity of matter were put into a convenient ſhaped glaſs, and aſſiſted with other friendly circumſtances, eſpecially if the luminouſneſs could be a little heightened, it may be rendred fit to be of ſome uſe in ſhips and magazines of powder.

If I had been furniſhed with accommodations, when I firſt made the foregoing experiment, I would have purſued the trial ſomewhat further, by making a pretty quantity of our noctilucal matter burn ſeveral times, in a thin glaſs veſſel exquiſitely cloſed with *Hermes*'s ſeal, that, by weighing the veſſel in exact ſcales, both before and after the accenſion of the included phoſphorus, I might find, whether any ponderable parts were ſubtile enough to pervade the pores of the glaſs; and in caſe they were not, I then hoped to diſcover, what change of texture might be made in the matter of a body, reduced to an actual flame, in a veſſel, wherein it could not receive the free air, nor emit any fumes or exhalations, which would have been to me a very acceptable experiment; and perhaps would have proved a very inſtructive one too. Since, as I have in another place complained, in the analyſes hitherto made by chymiſts, either the body expoſed to the fire has not been actually inflamed, which is the caſe of thoſe diſtilled in exactly cloſed veſſels, or elſe there has been ſome commerce betwixt them and the external air, which may juſtly render it doubtful, whether the bodies produced by this analyſis were the ſame both for number, nature, *&c.* that would have been produced in veſſels, exquiſitely cloſed; ſince we ſee, that wood, for inſtance, burned in a chimney, affords ſtore of ſoot and aſhes, which are very differing bodies from thoſe, that chymiſts obtain from the ſame wood diſtilled in cloſe veſſels.

But to trouble you no further with what I would have done, I ſhall add one circumſtance I obſerved in what was done. Namely, that ſometimes there appeared a little liquor in the glaſs (whether it conſiſted of ſome aqueous particles, that may be ſuſpected to have lain hid in the noctilucal matter, or were produced by the actual deflagration of a part of the matter) and the reſt of the matter, by the reiterated operations of the fire, was turned to a red colour, which it yet retains.

SECT. XIV.

EXPERIMENT I.

I HAVE formerly related, that, upon the immerſion of our phoſphorus into water, it would immediately ceaſe ſhining, and continue without light as long as it was kept under that liquor. This gave me ground to ſuppoſe, that, by the interpoſition of water between the noctilucal matter and the air, the phoſphorus may be kept unactive, till it be fitted, by an extraordinary agitation of its parts, to act with an unwonted vigour, when the air ſhall come to touch it ſuddenly: this ſuppoſition, I ſay, induced me to put two grains of our icy noctiluca into a ſmall glaſs egg, and pour a pretty quantity of water on it. In order to the following experiment, we heated the liquor well, yet without making it at all boil, and thereby melted the little fragments of ſolid matter, and made them flow into one liquid maſs, that kept itſelf at the bottom, diſtinct from the water: this done, we preſently removed the glaſs into a dark place, and pouring out the water, we obſerved, that, as ſoon as the air came to touch the noctilucal matter, it ſeemed to be kindled into an actual flame, that afforded a very vivid light; which ſucceſs pleaſed me the better, becauſe it ſhewed, that a kind of fire may be kept under water, as long as one pleaſes, without ſenſibly burning, and yet, in a moment, upon the bare removal of the water, ſhew itſelf in the form of actual fire. That our ſhining ſubſtance was of this nature, appeared manifeſtly by this, that the water, being poured out ſomewhat too haſtily, carried along with it, which I did not intend it ſhould do, the whole maſs of the noctilucal matter; and this, by its fall into the ſilver cup, that was employed to receive the liquor, was divided into two or three parts, which coming to a more free, or full contact of the air, blazed out much more than when they were in the glaſs, and afforded us a delightful ſpectacle, ſince the flame burned upon the water, with much light and fierceneſs, and a ſtrange deal of ſmoke, and it did, ever and anon, ſputter with noiſe, like ſalt-petre made to burn upon a live coal. Theſe flames continued the pleaſure we had to ſee them burn upon the water a pretty while; and after their extinction, looking into the ſilver cup, we found divers flakes of a reddiſh matter, (which the chymiſts would call a *caput mortuum*) that lay at the bottom of the water; and the ſides of the ſilver cup, that were next to that liquor, looked almoſt as if fine brick-duſt had been ſtrewed upon them.

EXPERIMENT II.

Being deſirous to ſee, whether our noctilucal matter ſhining through a coloured glaſs, the beams of light would be tinged in their paſſage, we took two or three grains of our matter, and put it into a phial, of an almoſt ſpherical figure, capable of holding, by our eſtimate, about twelve ounces of water; which phial was made of fine glaſs, of a very pleaſant colour, participating of thoſe, that are called orange and aurora: but the lucid matter being ſhut up in this phial, and carried into a dark room, did not appear through the glaſs to be conſiderably altered in colour; which becauſe I imputed partly to the ſmallneſs of the fragment of the phoſphorus, in reference to the capacity of the veſſel, through which it would give no more than a faint light, I cauſed the glaſs to be conſiderably heated, and then brought it into the dark room I ſtayed for it in: there, as ſoon as it was come, the included matter ſeemed to be actually flaming, and the trajected beams of light appeared of an unuſual and glorious colour, the light being ſo conſiderable, that it made divers bodies diſtinctly viſible, at a pretty diſtance from the glaſs; and we judged that, by the help of it, a book of a good print might have been eaſily read: but this light, which was the greateſt we had till then, produced with our phoſphorus, did not laſt long in its vigour, but, in a ſhort time, gradually decayed, till it came to little more than the uſual ſplendor of the noctilucal matter.

EXPERIMENT III.

I FORMERLY related, that I could not make ſuch an experiment, as I ſucceſsfully tryed with the oil of cinnamon and the oil of cloves, to ſucceed with the oil of mace. But now I muſt add, that the little phial, wherein the noctilucal matter, and that oil were included, having been ſet aſide as uſeleſs, I afterwards chanced to caſt my eyes on it, and to have the curioſity to try, whether or no the unſucceſsful experiment, I had made before, were not one of that kind, which, in another paper, I have diſcourſed of, under the name of contingent ones; and accordingly, there being a ſomewhat dark corner in the room, I carried the phial thither, and although it were yet broad day, I unſtopt it there, and was ſomewhat ſurpriſed to find the included matter to afford immediately a vigorous light, which put me afterwards upon repeating the experiment, at different times, which I did with the like ſucceſs, without being able to determine the cauſe of this odd phænomenon.

EXPERIMENT IV.

ONE experiment I ſhall now relate, which though (becauſe it ſeems, as well as the laſt recited, a contingent one,) I forbore to ſet down with the reſt, will perhaps be thought more ſingular than any of them.

WE had, in one of our receivers, that was but ſmall, (ſince it was not judged capable of containing a gallon of water) a parcel of our conſiſtent noctiluca, in which my laborant told me, that he had met with a phænomenon, that to him, who knew nothing of what is related *ſect.* XIV. *exper.* 1. was very ſurprizing, and ſeemed to appear by chance, ſince he often tried, in vain, to produce it when he pleaſed. This receiver I took into my cuſtody, and pouring out the common water, with which the ſplendid matter was kept covered to hinder it from ſteaming away, we obſerved no other change, than that, upon the removal of the water, and the contact of the air, the noctiluca would immediately ſhine, and continue to do ſo, till we thought fit to extinguiſh it *pro tempore*, by pouring water on it again.

THIS being done in the morning, I conſidered the following night, that this receiver having been kept in the laboratory, which conſtant, and ſometimes vehement fires, made a very warm place, it was but fit, in order to make the trial a fair one, to bring the ſhining matter to as great a warmth as it had in the laboratory, where it exhibited the phænomenon I was deſirous to ſee. Having then cauſed the receiver, with the water in it, to be held in a hot place, till the liquor had attained, by our gueſs, a fit degree of tepidity, we poured out the water, and, within a minute or two after, by our eſtimate, we had the pleaſure to ſee, that the conſiſtent matter, notwithſtanding the wetneſs, that in probability the water had left on it; we obſerved, I ſay, that this wet matter, upon the contact of the air, took fire of itſelf, not without noiſe, and burnt with a manifeſt and actual flame. But our pleaſure was ſomewhat moderated, though the experiment was the more aſcertained, by this accident; that, before we could pour in water to quench the fire, the violence of the flame had broken the receiver, which was thick enough, and thrown off a piece above half as broad as the palm of one's hand; by which unlucky chance we were hindred from endeavouring to find, as we intended to do, whether we could, by repeated trials, diſcover the cauſe of the appearing contingency of this odd phænomenon, which had, far oftner in vain than ſucceſsfully, been endeavoured to be produced.

THIS experiment recalls into my memory a notable phænomenon, belonging to that formerly recited (*ſect.* XI. *exper.* 2.) about the kindling of our phoſphorus with the ſunbeams, united by a burning-glaſs; for whereas I there mention, that the noctulucal matter did not burn all away at firſt, but left a kind of *caput mortuum*, which lay in the form of a cake variouſly coloured, I ſhall now add, that ſo much matter could not be left unfired, unleſs ſomething hindered its accenſion; we warily turned over the little cake, with the point of a ſharp knife, and then the under part, being I preſumed hot, preſently took fire upon the contact of the air, and flamed away, till the matter was almoſt totally conſumed.

The CONCLUSION.

AND now I have acquainted you with all the chief things, that I have hitherto been able to try or obſerve, about our icy noctiluca, or ſolid phoſphorus: and though I have been obliged to deliver them without any exact method, yet perhaps their novelty will ſerve to make them acceptable to you. Light is ſo noble a thing, that the matter our phoſphorus affords it to reſide in being endued with ſome uncommon qualities, and particularly with a ſtrange, and almoſt incredible ſubtilty of parts, I cannot but hope, that, if improvements, upon ſuch a matter, were more induſtriouſly attempted, by perſons better qualified for ſuch a work, than I (eſpecially in my preſent circumſtances) pretend to be, ſomething would be produced, tending to the diſcovery of the nature, not only of light, but divers other bodies, and perhaps alſo, of good uſe to human life. If ſome unwelcome circumſtances did not, for the preſent, diſcourage me, I would contribute my weak endeavours towards ſuch a deſign. For, ſometimes I think a naturaliſt's pen ought to be like a merchant's ſhip, that comes from time to time into port to reſt, but not always to ſtay there, but to take in new lading, and refit itſelf for a new voyage to the ſame, or other parts. In the mean time, I recommend this ſubject to yourſelf, and thoſe excellent virtuoſi, you hold correſpondence with, whoſe ingenious attempts to advance true philoſophy will have, for their good ſucceſs, the hearty wiſhes of

Your moſt affectionate
and moſt humble ſervant,
R. B.

A

CHYMICAL PARADOX,

GROUNDED upon

NEW EXPERIMENTS,

Making it PROBABLE,

That chymical principles are tranſmutable; ſo that, out of one of them, others may be produced.

An Advertisement of the Publisher to the Reader.

THE following paradox, having been written in or before the year 1680, was kept in the author's hands, that it might come out with the Latin verſion of his treatiſe, intitled, *The producibleneſs of chymical principles*, which is annexed to the ſecond edition of his *Sceptical Chymiſt*, printed 1680; but ſome unlucky accidents having kept that tranſlation from being finiſhed, the author thought fit the enſuing paper ſhould accompany his icy noctiluca, both in Engliſh and in Latin: upon this account, he ſent me not only the diſcourſe, that now comes forth, but ſome other papers, containing the minutes taken from time to time by his laborant, of what occured in the long train of diſtillations, on which the following reflections are grounded. For, the reader, whether foreign or domeſtic, may here be pleaſed to be advertiſed, once for all, that as the author hath been pleaſed to publiſh all his works in the Engliſh tongue, for reaſons beſt known to himſelf; ſo the province of the tranſlating them into Latin, hath been undertaken by others: for, indeed, his aſſiduity and diligent attendance on his daily and growing experiments will not allow him leiſure or opportunity to undertake that work, himſelf; though otherwiſe, if he had a deſire to poliſh any thing in that tongue, his pen can command a fluent ſtile. This by the by. But I having returned to the author, both his own papers, and my verſion of them, in one roll, it unfortunately happened, that before the icy noctiluca was printed off, there broke out, in the night, a great fire, not far from the author's lodging, which was ſo threatning, even after the blowing up of ſeveral houſes to ſtop it, that, as many others were obliged haſtily to remove their goods, our author thought fit, by the ſame way, to endeavour to ſecure his own manuſcripts; but did it not ſo ſucceſsfully, but that ſome are yet miſſing; and, among others, the Engliſh and Latin papers lately mentioned. Notwithſtanding which, the importance of the ſubject, and the novelty of the experiments, prevailed with the author, (to prevent the like miſchance from happening to what he could retrieve concerning them) to communicate them to the curious, who will, by what I have here related, be enabled to underſtand what he writes at the beginning of that part of the following paper, which, becauſe it was written after the fire abovementioned, and very long after the reſt, he calls his poſtſcript.

A CHYMICAL PARADOX.

I Adventured many years ago, in the *Sceptical Chymiſt*, and long after in other papers, to lay down ſome reaſons of queſtioning, whether the fire be the true and proper inſtrument of analyzing mixed bodies, and do but diſſociate their principles or ingredients, without altering them or compounding them anew. But I ſhall now preſent you a diſcovery, that will perhaps make you think the vulgar opinion of chymiſts to be leſs fit to be doubted of, than rejected. The occaſion of making the following experiments was afforded me by the complaint of an ingenious chymiſt, (and great diſtiller) who told me, that endeavouring to purify an eſſential oil by rectification, he found to his diſappointment, that he diſtilled it four or five times ſucceſſively, yet it ſtill left ſome fæces, (but much leſs than at the firſt) though he concluded, that if he ſhould undergo the trouble of diſtilling the liquor a few times more, it would come over perfectly pure, without leaving any fæculency behind it. But it was more congruous to my hypotheſis, to conjecture, that the *caput mortuum* he complained of, was not, (at leaſt after the firſt or ſecond diſtillation,) a more groſs or fæculent part of the oil, ſeparated from the more pure, but a new compound produced, as other concretes alſo might be, by the operation of the fire. This conjecture of mine was favoured by ſome experiments I had made many years before, and imparted to ſome inquiſitive men, whereby two diſtilled liquors were made, barely by their mutual re-actions, to afford great ſtore of an earthly and very fixed ſubſtance. And to the ſame conjecture it was ſuitable, that, by obſtinately reiterating the experiment, the action of the fire upon the parts of the body expoſed to it, and their mutual operations and combinations among themſelves, and, not improbably too, the material concurrence of igneous particles might produce, beſides earthly fæces, other bodies not unlike thoſe, that paſs for the chymiſts principles. How far the event proved agreeable to his hypotheſis, will be beſt gathered from the phænomena themſelves of the trials, which I ſhall proceed to ſet down a ſuccinct account of, as ſoon as I have premiſed, to make way for it, that by an eſſential oil, chymiſts are wont to mean ſuch a fine oleagenous liquor, as, to prevent empyreume and fæculent parts, has been diſtilled with ſtore of water in a (veſica or) limbeck.

We took a pound of eſſential oil of anniſeeds, which liquor we therefore made choice of, becauſe it is more eaſy to diſcern it, by its ſelf-coagulating property, not to be ſophiſticated; and having put it into a glaſs retort of a convenient ſize, we cauſed it to be diſtilled (in a ſand-furnace, capable of giving a ſtrong fire) thirty ſix times, in which train of operations, the enſuing phænomena were both congruous to our hypotheſis, and in themſelves obſervable.

1. As pure as the eſſential, or, as ſome ſpagyriſts ſtile them, the ætherial oils of vegetables are preſumed to be, and as confidently as chymiſts pretend they are, the pure ſulphurs or unctuous principles of the bodies that afford them; yet, not only the firſt diſtillation left a ſubſtance black like pitch, at the bottom of the retort, but, at every one of the following diſtillations, ſuch a ſubſtance was either ſeparated or generated.

2. Though after a diſtillation or two it ſeemed likely, that this pitchy ſubſtance would be found every time leſs and leſs, which made the perſon, formerly mentioned, tell me, that he ſuppoſed within ten, or at moſt twelve diſtillations, in all, if one ſhould make ſo many, this, which he looked upon as an earthy ſecrement, would be quite ſeparated, and leave the oil a moſt pure and homogeneous liquor; yet I, that (as I formerly intimated) looked upon this black ſtuff not as a ſeparated excrement, but generated ſubſtance, cauſed the diſtillations to be repeated, till they had attained thrice that number, and not only found, that at each time ſuch a black ſubſtance was left; but that now and then a ſubſequent diſtillation yielded much more of it than the precedent had done; which change, from leſs to more, and from more to leſs, was not obſerved only once or twice, but ſeveral times. And though this odd pitchy ſubſtance were, towards the latter end, found in leſs quantity than at the beginning, yet the cauſe of that may well be, that the oil to be diſtilled did ſenſibly, from time to time, decreaſe in bulk, partly by reaſon of the receſs of that portion of the oil which could not but be diſſipated and loſt in ſo many cohobations; and partly, and indeed chiefly, by the loſs of ſo much oil, as was tranſmuted into pitch and other ſubſtances.

3. The oil appeared in diſtillation more fixed or unapt to riſe, than one would have expected from ſo fine and light a liquor; and eſpecially towards the latter end of the diſtillations, it was often neceſſary to employ a ſcarce credible degree of fire to elevate all, that was not turned into pitch.

4. The liquor did not diſtill like a pure principle or homogeneous body, as quickſilver is wont to do, but firſt ſome fine and light oil uſually came over, after which followed a leſs volatile oil with another ſubſtance or two, and after that, another aſcended in a diſtinct manner.

5. For it is to be noted, that, beſides the forementioned black earth, there were produced, by the operation of the fire, divers other ſubſtances, whereof the firſt was a wateriſh liquor or phlegm, which, after the oil had been expoſed to ſome diſtillations, began to grow very troubleſome. For being rarified by the heat of the fire into large bubbles,

bles, the antipathy, or rather incongruity, between them and the oil, occaſioned a kind of conflict, wherein theſe bubbles did often ſuddenly break, (uſually not without much noiſe) and ſometimes with ſuch violence, as to ſhake and endanger the retort; which once, by this conteſt, was actually broken; yet not ſo, but that the liquors, and other products of the fire, were ſaved by the watchful laborant, and ſeaſonably transferred into a new retort.

6. Besides this phlegm and the pitch formerly taken notice of, our operation afforded us, from time to time, a pretty quantity of a certain ſubſtance, which, with ſome not unſkilful perſons, paſſed for a volatile ſalt; becauſe it aſcended to the upper part of the veſſel, and appeared in a dry form, almoſt like ſhort needles; and becauſe alſo it ſeemed to the laborant, that, like a ſalt, it was (part of it at leaſt) diſſoluble in the ſpirituous phlegm mentioned in the laſt number. But though at firſt I inclined to this opinion, yet having made ſome few trials to examine the truth of it, I was, and ſtill am, a little doubtful, whether this ſublimed body deſerve the name of a true volatile ſalt, though poſſibly there may be a pretty deal of that contained in it. For I found the lumps of it, notwithſtanding their ſeeming ſpungineſs, to ſink in common water, and continue at the bottom of it, without manifeſtly being diſſolved by that liquor, (as meer volatile ſalts are wont eaſily to be) either in the cold, or by being kept awhile in a moderate heat. I found this ſubſtance fuſible, like bees-wax, at the flame of a ſmall taper; and if a lump of it were kindled thereat, it would burn away, partly with a yellow flame, and partly with a flame more intenſly blue than that of rectified ſpirit of wine; but it appeared apt enough to go out of itſelf.

These, and ſome other things inclined me to look upon our anomalous ſublimate, as a ſubſtance *ſui generis*; but yet ſuch a one, as I ſuſpected to be ſomewhat of kin to a *ſal volatile oleoſum*, ſuch as camphire ſeems to be. For our ſublimate riſes without ſtrong fire, and that in a dry form, and is eaſily enough fuſible; all which I have obſerved in camphire, as well as in volatile ſalts; and our ſublimate will, like camphire, diſſolve in a high rectified vinous ſpirit without at all colouring the liquor. And having long ſince found by trial, that camphire will, though ſlowly, diſſolve in good oil of vitriol, and make the menſtruum look of a reddiſh brown; I put ſome of that ſolvent upon our ſublimate, and after having left them ſome hours together, though but in the cold, the liquor ſeemed to have diſſolved part of the dry body, having, by its action upon it, acquired a brown colour ſomewhat inclining to red; and part of this liquor being put into a pretty deal of common water, there ſeemed to emerge by degrees a dry body or flores, which brought into my mind what I have elſewhere obſerved, when I employed the ſame method, to recover camphire out of oil of vitriol. But, as I was lately intimating, though I think it not improbable, that our anomalous ſublimate may be nearer of kin to a *ſal volatile oleoſum*, than to any of the chymical principles; yet I have not hitherto found the reſemblance betwixt it and ſuch a ſalt to be compleat enough, to make me dogmatical in referring it to any chymical product of a known denomination: and therefore, till I be further ſatisfied, I ſhall only add, that this volatile ſalt, or oily ſublimate, or whatever name it may deſerve, was very pretty to look upon, being glittering almoſt like ſome fine flowers of *Benzoin*; and of this we had, though it were very light, between two or three drams.

7. Besides all theſe differing ſubſtances, our oil of anniſeeds afforded us, from time to time, a little quantity of ſpirit, as we concluded from two or three ſigns: one, that it came not over with the phlegm, and yet would mingle with that liquor, but not with the diſtilled oil; and another, that, as it was more fixed than the oil and phlegm, ſo it roſe later than they; and not only needed a ſtronger degree of fire, but, which is chiefly conſiderable, it was uſually obſerved to come over in white fumes, as many ſpirits, that are ſomewhat fixed, are wont to do; which was the more eaſy to be obſerved, becauſe, that being willing to make uſe of the ſame retort as long as we could, for the greater certainty of the experiment, and the pitch being not to be taken out, whilſt it was any thing ſoft, becauſe of its cloſe ſticking to the glaſs, it was thought, to give at the latter end of the diſtillation ſo ſtrong a fire, as, by making the ſand and retort red hot, (or very little leſs hot) would make the pitch ſo dry and brittle, that it might afterwards be looſened from the ſides of the glaſs, and got out in the form of a dry and brittle, though exceeding black ſubſtance. And to the two foregoing ſigns I ſhall now add a third, that does more clearly evince, that the ſubſtance, we have been ſpeaking of, was a ſpirit: for, though it could not but be very much weakned by being diffuſed through ſo great a quantity of phlegm as came over before it, yet its corpuſcles were ſo many and vigorous, that when I put them upon the powder of crude coral, they preſently began to diſſolve it; and the phlegmatic ſpirit did in a trice make a great ebullition with noiſe and bubbles, whether I poured it on the fixed ſalt of tartar, or the urinous and volatile ſalt of ſal armoniack.

The ſucceſs of this experiment, being anſwerable enough to what I deſired and expected from it, allowed me to make divers reflections on it, and particularly thoſe that follow.

And, 1. Our trial argues, that a ſubſtance, that is looked upon by chymiſts as a homogeneous body, and which paſſes for one of their principles, (for that is the caſe of our eſſential oil of anniſeeds) may yet be of ſuch a nature, that, barely by the further action of the fire, it may be made to afford a very conſiderable proportion of a ſubſtance, exceedingly different from that which afforded it. For in our experiment, we obtained a *caput mortuum*, whoſe qualities were quite other than thoſe of oil of anniſeeds; ſince it was opacous, black, dry, very difficultly fuſible, and fixt in ſo ſtrong a degree of fire, as made the retort, that contained it, and the ſand about it, red hot. This ſubſtance would lie undiſſolved in a highly rectified vinous ſpirit, into which oil of anniſeeds would readily have diffuſed itſelf (if they had been a little ſhaken together) without the help of heat. And though we made the liquor actually boil a pretty while, yet moſt of the *caput mortuum* continued a black ſubſtance; only it diſcoloured the menſtruum, which looked as if it had rather extracted a tincture, than made a ſolution properly ſo called. And of this black and pitch-like *caput mortuum*, we had at the end of our diſtillations, when we weighed the ſeveral parcels altogether, not much leſs (which you may juſtly think ſtrange) than half the weight of the whole oil of anniſeeds; this black ſtuff amounting to a pretty deal more than ſeven ounces. And from hence we may collect, that the analyſis, wont to be acquieſced in by vulgar chymiſts, is as yet but an undetermined thing, ſince they have not declared (nor perhaps thought of any ſuch thing) what number of diſtillations, (whether one or more, or if more than one, how many,) ſhall be made the ſtandard, by which we are to conclude, that a ſubſtance, obtained by diſtillation, is a chymical principle.

2. It may be alſo inferred from ſome phænomena of our experiment, that the fire, as it is wont to be employed, is not, as chymiſts pretend it to be, the true and genuine inſtrument of the analyſis of bodies, ſince it does not, as they preſume it does, barely extricate and ſeparate the ſeveral ſimilar ſubſtances, that, though concealed and diſguiſed by commixtures with each other, were pre-exiſtent (in the ſame forms wherein they afterwards appear) in the body expoſed to its operation. For in our caſe, the oil of anniſeeds is, according to the chymiſts eſtimate, the ſulphureous principle of the concrete; and therefore has not any other principles, eſpecially in any conſiderable quantity, contained in it. And yet, by the bare action of the fire, this oil, which they acknowledge to be a ſimilar body, is brought to afford three or four other ſubſtances of differing natures from one another.

3. From the two foregoing obſervations we may likewiſe deduce, that the fire, at leaſt in divers caſes, may not only ſeparate, but variouſly compound and alter, the parts of a body expoſed to its action; and thereby give conſidering men cauſe to ſuſpect, that divers ſubſtances, that are preſumed to be only extricated or extracted by the operation of the fire, may be really produced by it.

4. Agreeably to which ſuſpicion, it happens unluckily enough for the chymical hypotheſis; that in our experiment the ſubſtances, that were obtained, were a fixt and earthy powder, a not inconſiderable portion of phlegm, a ſpirituous liquor, and a dry ſublimate, a-kin to a volatile ſalt: and theſe, though they all proceed from a body, that, according to the chymiſts, ſhould not, and indeed, for aught appears, did not actually contain any of them before, did yet ſo reſemble in qualities the earths, phlegm, and ſpirit, that chymiſts obtain by diſtillation from thoſe bodies they look upon as perfectly mixed and compounded; that if they are not the ſame, they have divers qualities ſo like thoſe, that entitle what is afforded by confeſſedly mixed bodies to the name of phlegm or ſalt, or ſome other primordial ingredient, that the earth, for inſtance, or the (acid) ſpirit obtained in our experiment, are far leſs differing from the earth of blood, or the ſpirit of amber, than theſe are from the earth and ſalt of throughly calcined hartſhorn.

5. It will ſcarce be neceſſary to draw ſo obvious a corollary from what has been already delivered, as this; that it is poſſible, that chymical principles (or at leaſt ſuch ſubſtances, as a vulgar chymiſt, not knowing from what body they were obtained, would look upon as ſuch) may be made of another.

But though I ſhall not enlarge on this corollary, it will not be amiſs to make one conſiderable obſervation, that belongs to it; namely, that acid and aqueous ſubſtances, how differing ſoever each of them is from a pure oil, may be produced from it by the action of the fire. For I found by trial, that in that liquor, which the laborant took for the phlegm of oil of anniſeeds, there was ſuch ſtore of acid parts, that (as was above recited) they would readily diſſolve powdered coral, though crude, even in the cold; and would make a great conflict with ſalt of tartar, and with that of urine, as ſoon as the liquor was put upon it. But yet the greateſt part of the liquor, by far, ſeemed to be of an aqueous nature, which a chymiſt would call phlegm; which is a body, that will not mingle with oil, and is otherwiſe exceedingly different from oil, eſpecially an eſſential one, (ſuch as that of anniſeeds,) whoſe purity makes it totally inflammable. And the quantity of the whole liquor, conſiſting of acid and phlegmatic parts, was far from being inconſiderable, amounting to about two ounces and three quarters. It may alſo be worth while to obſerve, as another thing belonging to our corollary, that the truth declared in it allows us to queſtion, whether it be neceſſary to ſuppoſe with the chymiſts, that nature has been obliged to make proviſion of great quantities of primordial and ſimple bodies; and that ſhe is ſollicitous to mix them all together, for the compoſing of a body, capable of affording, by the analyſis or ſeparatory operation of the fire, ſalt, ſpirit, ſulphur, phlegm, and earth. I will not hence univerſally infer, that there are no ſuch ſubſtances, one or more, to be found, in any of of thoſe bodies, that are called perfectly mixed, antecedently to their being expoſed to the fire. But this, I think, will follow from what has been delivered, that the pre-exiſtence of ſuch ſubſtances muſt be made out by ſome other way, than the bare operation of the fire; and that the grand chymical ſuppoſition will not hold in all bodies, that what ſimilar body ſoever is obtained by the operation of the fire from a concrete, committed to diſtillation, was formerly and actually pre-exiſtent in it.

6. And laſtly, our experiment affords us a conſiderable argument in favour of that part of the corpuſcular or mechanical hypotheſis, that teaches inanimate bodies to differ from one another, but in the bigneſs, ſhape, motion, contexture, and, in a word, the mechanical affections of the minute parts they conſiſt of. For in our experiment, we ſee, that oil of anniſeeds, which is not only an uniform or ſimilar body, as to ſenſe, but is judged ſo by chymiſts, upon an analyſis of the concrete that afforded it, is, by having its parts variouſly agitated, ſhaked and rubbed againſt one another, and in differing manners broken, aſſociated, and ranged, tranſmuted into four bodies of ſuch differing natures and qualities, as the chymiſts principles and elements are known to be; and this, without the help of any true ſeed or plaſtick principle, by the bare operation of the fire, which *Helmont* calls *the artificial death of things*, and *the deſtroyer of ſeminalities*. And this is the more conſiderable, becauſe, whereas the ancient corpuſcularian philoſophers aſſigned three general ways, whereby bodies may be produced; namely, by the addition of new parts, the dividing and ſometimes taking away a portion of the former, and the tranſpoſition of the conſtituent parts; in our experiment, the whole work ſeems to be performed only by what they would have called tranſpoſition, and that guided but by ſo ſimple, impetuous, and unruly an agent, as the fire. Unleſs it be ſaid, that divers igneous particles, that penetrated the glaſs retort, did ſubſtantially aſſociate themſelves with ſome parts of the oil of anniſeeds, and concur with them to compoſe the pitch-like *caput mortuum*; which they will perhaps ſay, that (whatever others may do) I ought to allow as a poſſible thing, after what I have elſewhere written, purpoſely to ſhew, that ſuch a penetration of the pores of glaſs, by the atoms of fire, is not impoſſible. But the experiment, I have delivered, of the ponderability of flame, prove only, that ſome of its particles may combine with heavy bodies, and fixed in the degree of fire I expoſed them to; my trials having been made upon tin and lead. And it will not perhaps be thought likely, that igneous atoms ſhould, by their combination with the particles of an inflammable oil, produce an aqueous liquor, and that in great quantity; as we lately noted of the acid phlegm of anniſeeds, amounting to two ounces and almoſt ſix drams.

Upon the whole matter, the phænomena obſervable in our experiment upon oil of anniſeeds ſeem very congruous to the mechanical hypotheſis, and very unfavourable to that of the chymiſts. For, whether the fire be ſuppoſed to have acted meerly as an agent, or efficient cauſe, or to have alſo concurred as a material one; it appears, that by changes of texture, without the addition of any viſible parts, or of any ſeed, bodies very differing in colour, conſiſtence, fixity, and divers other qualities, may be produced from a body, not only homogeneous as to ſenſe, but pure enough to paſs for a chymical principle. And though the ſuſpicion lately propoſed ſhould be allowed to be probable, as to the other products, as well as to the black ſubſtance; yet ſtill our proceſs upon the oil of anniſeeds would afford conſiderable corollaries againſt the chymical doctrine I call in queſtion. For, 1. The objection we are conſidering will give wary men juſt ground to ſuſpect, that in ordinary chymical diſtillations the fire is not always to be looked upon as a meer inſtrument of analyſis; but may, in many, if not in moſt caſes, be alſo a material cauſe of the ſuppoſed principles produced by its means; which is quite contrary to the received doctrine of the vulgar ſpagyriſts, (who are thoſe, I now diſpute with.) But, not to inſiſt on this remark, I think our proceſs upon oil of anniſeeds will not ſerve to prove the paradox propoſed at the beginning of this paper; ſince, treating of ingredients chymically obtainable, I may be allowed to ſpeak of them in the uſual ſenſe of chymiſts, who ſuppoſe the different ſubſtances, obtained from a body committed to diſtillation, to be the hypoſtatical principles, and other ingredients of it, without ſuppoſing the fire to do any more than extricate or diſentangle them from one another. So that, ſecondly, (to conclude at laſt this long paragraph) our experiment ſeems to prove the production of other chymical principles out of one, as validly as their experiments prove, that ſuch principles are obtained from the bodies they call mixed. For, whereas the force of the lately propoſed ſurmiſe or objection lies in this, that the aſſociation of igneous particles hinders the different ſubſtances, that our oil of anniſeeds afforded us, from being uncompounded bodies, and therefore, from being true principles, they may, for all this, have as good right to the title of principles, as moſt of theſe they will have us take for ſuch; ſince the atoms of the fire may every whit as reaſonably be ſuppoſed to aſſociate themſelves variouſly with the corpuſcles of a mixt body, committed to diſtillation, as with thoſe of oil of anniſeeds, and ſo their ſuppoſed principles will, no more than ours, be free from compoſition. Nay, the advantage in the compariſon lies on our ſide, ſince the different ſubſtances, that chymiſts are wont to obtain from a mixt body, may be compounded, not only with igneous particles, but with the differing ingredients of the ſame body; ſince this, in their hypotheſis, is a mixt body; whereas eſſential oil of anniſeeds is by them granted to be a ſimple one; and therefore each of its productions is compounded with no extraneous ſubſtance, ſave the corpuſcles of the fire.

WHEN I had framed this conjecture, that from a chymical principle ſeveral differing bodies might be obtained by the mere operation of the fire, I thought fit to endeavour the confirmation of it, by making experiments upon other diſtilled oils, (for those made by expreſſion are, by chymiſts themſelves, owned to be compounded bodies,) of natures different, both from the oil of anniſeeds, and from one another. And accordingly, whilſt our proceſs with this oil, which the chymiſts call eſſential, and which was drawn from a vegetable ſeed, was carrying on, I took care to have diſtilled in the ſame furnace oil of turpentine, which, though drawn from a vegetable ſubſtance, differs very much from oil of anniſeeds; as alſo oil of amber, which, according to chymiſts, belongs to the mineral kingdom; and laſtly, oil of hartſhorn, afforded by a ſubject, which (to ſpeak in their phraſe) belongs to the animal kingdom.

POST-SCRIPT.

THESE oils were committed to the ſame laborant, that managed the lately mentioned oil of anniſeeds; and he accordingly kept a kind of journal of the number of rectifications, the quantities of pitchy matter from time to time afforded by them, and divers other phaenomena, or circumſtances, that occurred in ſo tedious a proſecution, as I thought experiments of ſuch moment deſerved. But the papers, containing the minutes of theſe things, having been unhappily loſt, with divers others, by occaſion of a great fire, that obliged me, after midnight, to make a haſty and very diſorderly remove of my writings, I could never ſince retrieve the particulars. And therefore I muſt content myſelf, to ſet down as much of the trials, (which I hope will comprize the moſt ſubſtantial part of them) as by examining my own memory and the laborant's, and by ſome few other helps, I am able to collect; as ſoon as I have given here one advertiſement, becauſe I think it was omitted in the papers, whence the foregoing part of this writing was tranſcribed. The advertiſement is this; that as well in the precedent, as in the ſubſequent part of this diſcourſe, I do not take chymical principles in the ſtricteſt ſenſe of that term, wherein it is confined to ſalt, ſulphur, and mercury; but in the larger acception, wherein the learned doctor *Willis*, and divers other chymiſts (that are not all his juniors) employ it, when they comprize under it two elementary bodies; as they do, when they conſtitute five principles, (which perhaps might be more clearly called ſimilar ingredients;) in which number they comprize phlegm and earth, which other chymiſts, as well as the Ariſtotelians, would call elements, (of the body that affords them.) Taking then, in this whole writing, the word principles in the larger ſenſe above declared (congruouſly whereunto I uſually call them the chymical principles indefinitely, not the hypoſtatical principles, which are accounted but three;) I proceed to the particular obſervations and reflections I was going to begin.

Firſt, THEN it plainly appears, that two of the three lately mentioned oils, namely, the oil of turpentine, and the oil of amber, and therefore very probably the third alſo, (my deſign being the ſame in all three) were diſtilled at leaſt fifty times; for I intended not to ſtop ſhort of that number. And by an inſcription upon one of the phials, I found, that the oil, which the contained liquor was drawn from, had been diſtilled one and fifty times; which number exceeds, by fifteen, that of the diſtillations formerly mentioned to have been made of the oil of anniſeeds.

2. EACH of the three other oils, (*viz.* that of hartſhorn, that of turpentine, and that of amber,) did leave, from time to time, in the bottom of the retorts, whence they were drawn off, a not inconſiderable quantity of black faeces, much like thoſe, that were left by the oil of anniſeeds, and which I have formerly called a pitchy ſubſtance. I found in a ſuperſcribed paper ſome quantity of this ſtuff left by the oil of turpentine; and, though I am not certain, whether it were all the ſtuff of this kind, that was afforded by the pound of oil we employed, yet it amounted to above two ounces and five drams; and, if I much miſtake not, the other two oils did each of them afford a conſiderable quantity of black terreſtrial matter, though the heedful laborant obſerved, that the oil of hartſhorn did ſooner leave off yielding copious faeces (as I often in this paper call them, to comply with the chymiſts terms, though I aſſent not to their notion) than, the oil of turpentine, or that of amber. But if neither of the two afforded any more than did the oil of turpentine, I look upon it as a remarkable thing, that the oil of anniſeeds, which is a fine eſſential oil, diſtilled in a veſica or limbeck, ſhould yield above twice more of earthy matter, than either of the three other oils, that were diſtilled but in retorts.

3. OF the colour of the rectified oil of hartſhorn I can ſay little, having unluckily loſt the liquor itſelf; but the oil of amber, after the one and fiftieth diſtillation, was indeed very clear, but yet of an amber colour, that was far from pale; and the oil of turpentine, that is uſually after one rectification a clear and colourleſs liquor, after fifty diſtillations appeared almoſt red.

4. BUT that is much more conſiderable, which I obſerved in the quantities of the different liquors afforded by the long ſeries of our diſtillations; for at the end of the pro-

tafe, the remaining oil of turpentine, for inſtance, did not appear to my eyes to be conſiderably, if at all, ſuperior in bulk to another liquor, that came over with it in diſtillation, and was not true oil; for it would readily enough mix with water, but keep itſelf in a maſs diſtinct from the oil, and weighed above three ounces and three quarters.

5. This oddly produced liquor I looked upon as compounded of ſpirit and of phlegm: for though the latter did ſo much exceed the other in quantity, that, in an expert chymiſt's opinion, the whole liquor paſſed for phlegm; yet, I not only judged ſome parts of it to be ſpirits, but found them to be of an acid nature too; ſince, beſides what the taſte made me ſuſpect, I found, that the compounded liquor would readily enough begin to corrode beaten coral, even in the cold, and ſome of it being poured upon good ſalt of tartar, preſently made with it a conflict and ebullition, not without a hiſſing noiſe and a multitude of bubbles. So likewiſe the ſpirituous phlegm of amber made a conflict with ſalt of tartar, and diſſolved crude coral, as other weak acid ſpirits are alſo wont to do. This liquor of amber was not pale, as the phlegmatic ſpirit of oil of anniſeeds was; and that lately mentioned to have been obtained from oil of turpentine was high coloured, being of a browniſh red.

6. I forgot to take notice in due place (and therefore do it in this) that, among other trials made to diſcover, that the ſpirits afforded by our oils were really acid, we put two ounces of the ſpirituous phlegm of oil of anniſeeds (that being the mildeſt oil) upon ſome minium; and, having digeſted them a while together, found the liquor turned ſweet, and fit (as we judged) to make *Saccharum Saturni*: and this liquor (after filtration through cap-paper) being gently abſtracted, left in the bottom of the retort a thick honey-like ſubſtance, from which (the diſtillation being continued in the ſame retort, but with a much ſtronger heat) there came over ſome liquor, which being in too little quantity to be rectified, we could not free it from its phlegm, and therefore did not find it inflammable; as I gueſſed the ſpirituous part would have been after rectification, in regard the liquor was exceeding like the *Spiritus ardens Saturni*, I have elſewhere deſcribed, in its peculiar and very penetrating taſte and ſmell.

7. It may not be unfit to be taken notice of in this place, that having lighted on two vials, that I long knew not what was become of, one of which contained ſome of the oil of turpentine, and the other ſome of the oil of amber, that I formerly mentioned to have been each of them diſtilled at leaſt fifty times; I thought fit to try, whether, after theſe liquors had been laid by about a year and half, or longer, they would, after having had ſo long a time to defecate themſelves in, yield ſtill ſuch a black ſubſtance as has been oftentimes mentioned; and having, to ſatiſfy myſelf, cauſed each of theſe liquors to be again diſtilled in a retort, it left behind it a greater quantity of a black and ſhining ſubſtance, than could well have been expected.

8. It may ſeem very odd in itſelf, and may much ſerve to confirm what I have elſewhere delivered about the mechanical origin of fixity, as alſo of the qualities oppoſite to fuſibleneſs and to fluidity; that ſo volatile and thin a liquor, as a chymical and rectified oil, ſhould, by the bare operation of the fire, be brought to yield a great quantity of what looks ſo like terreſtrial fæces, as our pitchy *Capita Mortua* did. But this reflection will, I preſume, appear the better grounded, if I add the ſucceſs of one trial (among others) that I made, to examine the terreſtrial nature of the black bodies I am ſpeaking of; for, although many bodies, that will not aſcend, or be diſſipated in cloſe veſſels, will eaſily be driven away in open ones; yet having put one ounce of the *Caput Mortuum* of the oil of anniſeeds, and as much of that afforded by oil of turpentine, each of them into a diſtinct crucible, and kept them three hours and a half, or near four hours, in ſuch a heat as made the veſſels all the while red hot; though we kept not the crucibles cloſely covered, but only looſly to keep out the aſhes, yet we found, when the veſſels were removed from the fire, that the contained bodies had not at all been brought to fuſion, only that from the oil of anniſeeds was in part ſomewhat caked together: and notwithſtanding all the heat they had been expoſed to, the pitchy ſubſtance of the oil of turpentine retained not far from three quarters of its firſt weight; and the *Caput Mortuum* of oil of anniſeeds loſt about eighteen grains leſs than that.

9. After this we alſo endeavoured to diſcover, whether our pitchy ſubſtances would afford any fixt or alcaliſate ſalt, as the *Capita Mortua* of moſt bodies belonging to the vegetable kingdom are wont to do. But though we kept an ounce a-piece of the black ſubſtances, left by the oil of anniſeeds and that of turpentine, for nine or ten hours, red hot in the crucibles; yet we found indeed the bodies very much diminiſhed in quantity, but they did not appear at all calcined.

10. Into a couple of ounces of this laſt named liquor, we put, by little and little, as much of dry ſalt of tartar, as it would work upon, as an acid, or (if you pleaſe) till there would no longer be any viſible conflict excited by adding more ſalt. The acid being thus mortified or ſatiated, I intended to draw off all the reſt of the liquor, and to try with the phlegm drawn off, whether, by cohobating it very ſlowly in a new glaſs head and body, I could not make a farther tranſmutation of the terebinthinate oil, and change, at leaſt, part of this aqueous phlegmatic liquor into a whitiſh earth. About the poſſibility of which tranſmutation, and of ſome others alſo, I might here ſubjoin an account, if, ſince the lately mentioned fire, I could

have found a ſhort diſcourſe I wrote, to propoſe and examine this grand phyſico-chymical problem, whether we ought to admit any other elements or hypoſtatical principles at all, even ſo much as one of the bodies, that are commonly called, mixt?

A

CONTINUATION

OF NEW

EXPERIMENTS

PHYSICO-MECHANICAL,

TOUCHING THE

SPRING and WEIGHT of the AIR, and their EFFECTS.

The SECOND PART.

WHEREIN

Are contained divers EXPERIMENTS made both in compreſſed and alſo in factitious AIR, about FIRE, ANIMALS, &c.
Together with a DESCRIPTION of the ENGINES, wherein they were made.

The PREFACE to the LATIN Edition.

AFTER I had firſt publiſhed my phyſico-mechanical experiments to the curious world, and, ſome years after, the continuation of them, (together with a full deſcription of the engines, and leſſer veſſels, which I uſed in the making of them) I thought it a very venial thing in me, if, ſuperſeding any farther labour upon ſuch ſubjects, I left that argument to be ſtudied, and, if they had pleaſed, cultivated by others. And therefore I was content to annex only ſome experiments, occaſionally made, concerning reſpiration, concerning the ſcarce credible rarefaction of the air, and laſtly, concerning the preſervation of ſome bodies, whilſt they are defended from the contact of the air; in regard thoſe tracts were of kin to other arguments, which I had occaſion to handle at ſeveral times. But in ſeven or eight years ſpace, hearing of very few experiments made, either in the engine I uſed, or in any other made after the model thereof, I began to reaſſume ſome thoughts concerning the farther uſe thereof myſelf; at which time it happened very opportunely, that a certain tract written in *French*, ſmall in bulk, but very ingenious, containing ſundry experiments concerning the preſervation of fruits, and ſome other tracts of a different nature, was brought unto me by monſieur *Papin*, who had joined his pains with the eminent monſieur *Chriſtian Hugenius*, in making the ſaid experiments; and, upon farther diſcourſe with him, finding, that he came out of *France* into *England* but a little before, in hopes to obtain ſome place here, which might be fit for his genius, and, whilſt he was in that expectancy, that he was willing to beſtow his pains about experimental philoſophy, upon which, I had an inclination, at my coſt, to gratify his curioſity, whilſt I alſo indulged my own; and, ſeeing he had a pneumatic-pump of his own, made by himſelf, to the uſe of which he was more accuſtomed, though it differed from the ſtructure of my pump, I gave him the freedom to uſe his own, becauſe he beſt knew how to ply it alone, and (if any diſorder ſhould happen, from the luxation of its parts, or any other caſualty) how to repair it more eaſily. Though, in his abſence, I choſe rather to uſe my own pump, both becauſe my domeſtics were better acquainted with it, and alſo becauſe it was not ſubject to ſo many and frequent inconveniencies, by reaſon of its more ſolid ſtructure.

But, ſeeing ſeveral ſorts of experiments, long ſince made on divers bodies, had left me little to do about the ſame ſubjects, there were only two things, which I chiefly deſigned to proſecute. One of which contained thoſe experiments, which, when I firſt publiſhed my Phyſico-mechanical Experiments, I had wiſhed in general had been made, not in rarefied or expanded, but in condenſed or rather compreſſed air. The other was to be verſant about thoſe trials, which were not to be made, as the former, with natural air, either in its wonted ſtate, or any way rarefied, but factitious air, (that I may ſo ſpeak,) ſuch as, in my former writings, I had mentioned to be producible by the help of fermentations or corroſions. The divers ways of producing or extricating that factitious air, and the ways of trying it, when it was produced, having been ſome years ago preſented to the Royal Society, I was invited, by that learned aſſembly, to proſecute farther thoſe diſquiſitions. Now, although thoſe were the chief kinds of experiments, which I applied my mind unto, yet it will appear by the following ſheets, that I did not confine myſelf to them alone.

But, before I could make any conſiderable progreſs in this work, it pleaſed the moſt juſt and wiſe God, the ſupreme arbiter and ruler of all things, to afflict me with the ſtone (the pains whereof do as yet now and then trouble me,) ſo that I was enforced to take another courſe of proceeding. For, to eaſe myſelf, it was judged meet, that monſieur *Papin* ſhould ſet down in writing all the experiments and the phænomena ariſing therefrom, as if they had been made and obſerved by his own ſkill; and moreover, the calculation of the degrees of the rarefaction and condenſation of the air, included in our mercurial gage, was intruſted to his care. But I, myſelf, was always preſent at the making of the chief experiments, and alſo at ſome of thoſe of an inferior ſort, to obſerve whether all things were done according to my mind. But, as for thoſe experiments, which required a longer time in making, ſuch as thoſe about the conſervation of bodies, he did from time to time, with great diligence, acquaint me with thoſe alterations, which happened in them in my abſence; and he alſo brought the glaſs-inſtruments to me, and declared to me the effects of the experiments, when they were finiſhed, that ſo I might take into conſideration the changes made in the materials, when taken out of the veſſels. Yet, I confeſs, I was purpoſely ſomewhat more incurious and remiſs about thoſe experiments, which were made concerning the preſervation of fruits, and of fleſh in liquors, which was made chiefly by the help of compreſſion; and alſo about the coction of meat. For, as ſome of theſe later experiments were propounded for trial by monſieur *Papin*, for a particular end of his own, ſomewhat different from my deſign in the other experiments; ſo I was very willing, that he ſhould uſe his own method about them, not doubting but he would uſe his greateſt induſtry therein, as I found, by the event, that he had done. Yea, I did judge, that I might more ſafely acquieſce in his relations, concerning the experiments about fleſh, about fruits, and about boiling of meat; becauſe, as theſe were ſome of the laſt which we made, ſo I had cauſe enough to truſt his ſkill and diligence uſed about the former experiments; ſome of which, *viz.* thoſe which are marked with an aſteriſk, he himſelf propounded, as if they had been formed in his own brain; as alſo not a few of the mechanical inſtruments, (eſpecially the double-pump, and wind-gun) which ſometimes were of neceſſary uſe to us in our work, are to be referred to his invention, who alſo made ſome of them, at leaſt in part, with his own hands.

In the following tract, the reader will not find the reaſons ſubjoined, which moved me to make theſe experiments, (which I uſually did in my former Phyſico-mechanical Experiments, and in the Continuation of them) for I had neither leiſure, nor a mind free from other buſineſſes, to make ſuch a preface; and I did alſo hope, that the ſagacious reader would find out my ſenſe well enough, though purpoſely not expreſſed in plain words, if he did but attentively conſider the nature of the things treated of; eſpecially if calling in to his aid thoſe ſhort corollaries, which he will find annexed to the ſeveral experiments, whereby he may fiſh out my aim. Though, to ſpeak the truth, ſome few of thoſe inferences owe themſelves more to my aſſiſtant than to me.

I am well aſſured, that very many of the following experiments will not be thought weighty enough by many readers, as to deſerve to be printed; and indeed I myſelf was ſo far of their mind, that I had once thoughts of expunging them out of the following collection; but at laſt I was more eaſily perſuaded to afford them a place amongſt the reſt, becauſe, however they may be conſidered apart, yet, in conſort with the reſt, they may be, at leaſt, of moderate uſe.

I was not very ſollicitous about the ſtyle, becauſe, being infirm in point of health, and beſides, ſurrounded with many buſineſſes, I was enforced to leave the choice of words to monſieur *Papin*; my chief care being to have the whole work diligently read over to me, that ſo no miſtake might paſs by unobſerved about the experiments themſelves. Beſides, ſeeing the things here treated of are merely phyſical, and their manner of handling but hiſtorical, there is no need of any farther apology to excuſe the incomptneſs of the ſtyle: yet this may be alledged in excuſe thereof; that the heads of things (or memorials as they are called) being at firſt ſet down, for haſte, by monſieur *Papin* in his own native tongue, *ſcil.* the *French*, and afterwards turned into *Latin*, (in which habit they now appear) do labour with that inconvenience, which doth uſually attend all tranſlations, eſpecially where the interpreter muſt have a greater care of the propriety of words, than of the elegancy of them.

MOREOVER, he that ſhall attentively conſider the following experiments, will not wonder, that they are delivered in a leſs accurate method. For we accounted it ſufficient for our purpoſe, to reduce thoſe experiments, which did differ, and had leaſt affinity amongſt themſelves, into ſome certain heads, to which they ſeemed moſt commodiouſly to be referrable: and, beſides, conſidering the nature of the experiments themſelves, I hope the reader will eaſily grant, that at leaſt many of them ought to have been ſet down in the way of a diary, yet diſtinguiſhed, and, as it were, intercalated by frequent intervals, becauſe the examination of ſome of them was protracted for many days, the nature of the experiments themſelves, and alſo the deſign of the experimentators, requiring ſuch chaſms. Add hereto, that I was more willing to ſet down divers things with their minute circumſtances; becauſe I was of opinion, that probably many of theſe experiments would be never either re-examined by others, or re-iterated by myſelf. For though they may be eaſily read, when ſet down with pen and ink in paper-ſheets, yet he, that ſhall really go about to repeat them, will find it no eaſy taſk.

FOR there are ſo many, and ſuch ſundry ſorts of inſtruments, both of a greater and leſſer ſize, which are neceſſarily required for uſe herein, ſome of them to be made on purpoſe for the preſent occaſion; reſpect alſo being had to the time and aſſiduity, requiſite and neceſſary for making the experiments and obſervations, in caſes, wherein ſo ſubtile and elaſtic a body as the air is, muſt be violently reduced into a preternatural ſtate, and muſt be long kept in that diſpoſition; that, as it is a very difficult thing to prevent thoſe inconveniencies, which do attend ſo unuſual experiments, ſo it is far more difficult to apply remedies to thoſe inconveniencies, after they have once happened. For theſe, and other reaſons, ſo much time is to be ſpent, that I am almoſt aſhamed to tell, how much thereof was impended on theſe trials which are contained in the preſent book, though but ſmall, to which this proeme is prefixed.

NEVERTHELESS, though all theſe things are alledged in excuſe, yet the deficiency of this collection is ſo well known to me, (there being little to be found therein which may commend books) that I would invite very few philoſophers to the reading of ſo incult and unpolite a rhapſody, eſpecially from the beginning to the end. For though it may probably happen, that ſome experiments contained herein may not be diſallowed by the curious, yet they may have leave from me, to eſteem this whole tract but as a looſe heap (or rather chaos) of particulars belonging to the air, eſpecially as conſtituted in its preternatural ſtate, and to the operations of it upon ſome bodies, as clothed with ſuch and ſuch circumſtances: ſo that it is free for them to cull out only thoſe experiments, which pleaſe their curioſity, or any other of their concerns beſt, without being obliged to read over the whole book, no more than a lexicon, which we uſe not to conſult, but now and then, for the ſake of a word. In ſhort, it is not probable, that a book ſo impolite, as this is, will be either wholly read over, or can conciliate any favour from the reading, unleſs with thoſe readers, to whom a book comes ſufficiently commended only upon this accompt, that it contains things new and alſo true. For if thoſe two privileges are enough to obtain favour, then there is no cauſe, that the following tract ſhould wholly deſpair of the reader's benevolence, eſpecially ſince ſome trials contained therein do treat of the properties and operations of the air; I ſay, of the air, which, notwithſtanding the laudable endeavours of ſome ingenious modern writers in the explication thereof, yet is a body, which, I fear at preſent, we have greater uſe and neceſſity of than knowledge.

An ADVERTISEMENT of the PUBLISHER to the READER, before the Latin edition.

SEveral tracts, made by our author, printed at *Geneva*, and bound up in one volume, were not long ſince tranſported into *England*: in which matter, though the author himſelf doth not complain (which yet he might lawfully do) of the immoderate liberty of ſome men, who have preſumed, unknown to him, to bind up ſo many of his writings together, and to publiſh them; not to mention the print, as being but bad, (or at leaſt not accurate) yet there are two things in that edition, which, in our author's behalf, cannot be concealed without juſt reprehenſion, for they may impair his credit much, eſpecially with thoſe, to whom his writings are not otherwiſe known than by that collection.

For, firſt, there is no ſignification made therein, that any of Mr. *Boyle*'s tracts were ever written in any other language than that, wherewith they are there cloathed, *viz.* the *Latin*; whence it may probably come to paſs, that all the faults and defects of ſtyle, which are wont to blemiſh tranſlations, eſpecially ſuch as are literally made, may by readers, who are not otherwiſe informed, be imputed to the author himſelf, who, for reaſons often rendered by him, was induced to write all his works in the Engliſh tongue; the verſions of ſome of them into Latin being not ſo much as ſeen by him, till, being come from the preſs, they were put into his hands.

SECONDLY, the ſeveral tracts, making up that collection, are all dated in one and the ſame year, *viz.* 1677, as if they had been all, both writ, and alſo publiſhed, by our author, at once; whereas indeed ſome of them were made publick eight or 10 years, ſome 11 or 12, others 17 or 18 years before ever this collection ſaw the light. Hence an injury, greater than the former, may be offered to our author; for thoſe readers, to whom neither himſelf nor his lucubrations are known but from that volume, may be eaſily perſuaded to believe, that thoſe experiments, if perhaps they meet with the ſame, which are comprehended in theſe books, and are alſo found in other mens works printed before 1677, were transferred, by our author, out of their tracts into his own; than which nothing can be imagined or ſpoken at a greater diſtance from truth. For, indeed, if, applying myſelf for three whole years to manage the experiments of ſo great a perſon, and thereby having frequent opportunity to converſe with him, I ſometimes caſually light upon ſomething new, yet who ſees not, that thanks is to be returned to him alone, who afforded me both the occaſion of meditation, and alſo leiſure to operate? Yet ſuch is the humanity of this noble perſon, that he mentions my name in the preface to this book, as if ſome things therein were mine. Who then can juſtly ſay, hat he hath excerped any thing from other authors, who gives his own freely unto others?

[*The reſt of this advertiſement relates to a catalogue of Mr.* Boyle's *philoſophical writings, ſubjoined to it.*]

The TRANSLATOR to the READER.

THOUGH the firſt part of the Phyſico-mechanical Experiments of this honourable author was publiſhed by him in the Engliſh tongue, as was alſo, ſome years after, his firſt Continuation of the ſame; yet ſo welcomely were they entertained by the curious, eſpecially in tranſmarine parts, that the firſt part hath been long ſince publiſhed in the Latin tongue; and the firſt Continuation is alſo tranſlated in the ſame tongue, though (for reaſons, in part mentioned at the end of the publiſher's advertiſement to the reader, prefixed before this tract) not yet printed.

THIS ſecond Continuation of the aforeſaid experiments ſpeaks Latin at the firſt hand; but that all thoſe three tracts might be cloathed in one habit, it was the deſire of ſome ingenious perſons, that it might alſo be rendered into Engliſh; which province hath been recommended to me by the bookſeller.

I MAY without vanity affirm, that I have an advantage beyond ſome others, in reference to the verſions of any tracts of this noble author, either out of Engliſh into Latin, or out of Latin into Engliſh; in that, by reaſon of the vicinity of my habitation, I have conveniency, at fitting ſeaſons, to conſult the author himſelf, about his ſenſe in any place, which may be doubtful to me; which I mention, not only to declare the candour and condeſcenſion of ſo eminent a perſon, but alſo to account for any miſtakes I may be guilty of, which are therefore rendered the more inexcuſable in me, and properly to be laid at my own door.

IT is not to be doubted, but that, if the honourable author of theſe following experiments had himſelf at firſt dreſt them up in their Engliſh habit, they had appeared far more terſe and polite, than my inability can trim them up to; yet, beſides the neceſſary inconveniencies, which attend all tranſlations of books, (eſpecially thoſe, which treat of nice and curious ſubjects) which I alledge for part of my apology, I do farther relieve myſelf with that ſaying of the orator, *Si quis ſumma deſperet, tamen eſt pulchrum in ſecundis tertiiſve conſiſtere.* Quintil.

AND in reference to the elegancies of this noble author, in the Engliſh as well as other languages (of which he is ſo great a maſter) I may farther add, with the ſame orator, *Ut tranſeundi ſpes non ſit, magna tamen eſt dignitas conſequendi.* It is ſufficient honour for me to write after his copy. In fine, I conclude with the poet;

Veniam pro laude peto, laudatus abunde,
Si faſtiditus non tibi, lector, ero.

THE
Second CONTINUATION
OF
PHYSICO-MECHANICAL
EXPERIMENTS.

ICONISME I.

The deſcription of the engine, with a double tube, for the exhauſting of the air.

AA Are two pumps made of braſs.

BB are two plugs hollow within, and open below.

CC are two holes in the upper part of the plugs, with valves opening outwardly, that they may afford paſſage to the air to go out, and hinder it from coming in.

DDDD are iron rods ſerving to move the plugs, and annexed to them, by means of the gnomons FF.

EE are two flat iron ſtirrups at the top of the rods DD, on which the operator muſt ſtand to ſet a work the engine.

GGG is a cord joined to the two ſtirrups, and compaſſing the pully H.

LL are two valves at the bottom of the pumps, opening inwardly, for the admiſſion of the air out of the tube MM.

MM is a tube reaching from both pumps to the plate OO, by means of the curvature PP QQ; which curvature ought to be of ſo great length, that the tube P Q Q may not hinder the exerciſer of the pumps, but that he may conveniently ſtand on the ſtirrups EE.

OO is a plate bored in the middle, on which the receivers, to be evacuated, are to be put; as R for example.

Before this engine can be fit for uſe, it is to be put into a frame of wood to ſupport it, as is ſhewed in the ſecond ſcheme, and as much water is to be poured through the hole Q in the plate OO into the pumps, as is ſufficient to fill the cavities of the plugs, and a little more; and then ſome body muſt ſtand on the two iron ſtirrups EE, and muſt alternately depreſs and elevate them. For by this means it will come to paſs, that the plugs, following the motion of the ſtirrups in their aſcent, will leave the ſpace in the bottom of the pumps empty, and ſeeing all other paſſage is intercluded from the air, that air alone which is contained in the receiver R, is conveighed into the aforeſaid pumps by the tube Q Q PP M, and opens the valve L, which, being preſently ſhut, hinders the ſame air from making a regreſs: wherefore the plug, afterwards deſcending, compreſſeth that air, whence of neceſſity, the valve C muſt be opened, and all the air muſt paſs out at it, *viz.* becauſe the water, in the bottom of the pumps, doth exactly fill all the ſpaces, and doth alſo regurgitate through the valve C.

Here we may obſerve, that this double engine is, upon many occaſions, to be preferred before a ſingle one, (that is moved with the foot) for it doth not only produce a double effect, but performs it alſo much more eaſily; for in thoſe engines, which are furniſhed but with one tube, whilſt the plug is drawn up to evacuate the pump, the whole pillar of the air, incumbent on the plug, is to be elevated by force; and again, when the plug returns back, it is alſo by force to be reſtrained, leſt it ſhould be too ſwiftly impelled by the air, and ſo break the bottom of the engine; but in theſe double engines, the plyer of them is in a manner wholly free from that toil. For in the firſt ſuctions, the plugs are eaſily lifted up, becauſe the air, immediately derived from the receiver R into the pumps, preſſeth the plugs downwards, almoſt as ſtrongly as the external air incumbent on the oppoſite part; and when the quantity of the internal air is diminiſhed, it comes to paſs, that the plug to be depreſſed tends downward with ſo much the greater force; and ſo, by means of the cord GGG compaſſing the pully, draws the other plug upwards, and, at the ſame time, hinders it from too much velocity of deſcent. And by this means both plugs, at one and the ſame time, will be helpful to him, that exerciſeth the pumps.

Seeing the plugs make but a very ſmall reſiſtance, a man may eaſily judge, that the two pumps of this engine may be plyed with greater eaſe, and alſo with more ſpeed, than one pump in ſingle engines can; ſo that this engine is of great uſe in order to thoſe experiments, which cannot be well made but with velocity and ſpeed.

ICONISME II.

The deſcription of the mercurial gage.

THE firſt deſcription of a mercurial gage, to diſcover the degrees both of the rarefied and condenſed air, may be ſeen about the beginning of the Continuation of our Phyſico-mechanical Experiments: but thoſe gages, which I uſed in the following experiments, are declared in the ſubſequent ſcheme.

Fig. 1. THE whole gage ABCDE conſiſts of three glaſs tubes, all very well faſtened and cemented together, yet ſo, that a paſſage is open from one to the other; the firſt of theſe tubes AB being open at the extreme A, is of leſs capacity than the tube BCD, but of greater than the tube ED. The tube BCD is crooked in the middle, and the tube ED ought to be hermetically ſealed, at the extreme E, but the part BCD muſt firſt be filled with mercury.

THIS inſtrument, thus prepared, if it be put into a receiver, out of which the air is afterwards to be extracted, it will come to paſs, that the air remaining in the part ED, will, by its ſpring, compreſs the mercury DCB, and force it to aſcend into the part BA, and its ſelf will be dilated in the cavity DC. If then the proportions be duly obſerved between the bigneſs and length of the tubes, as ſhall be declared hereafter, when the air is extracted, the mercury will almoſt reach to the top A, and the air in the other leg, being ſo dilated, that it cannot ſuſtain a greater body of mercury, will be kept included in that place.

BUT that this inſtrument may exactly tell the quantity of the air produced in its receiver, the tubes AB ED are to be diſtinguiſhed by marks into ſeveral parts; and when the Torricellian experiment is tried, above the plain plate LM of the pneumatick engine, as you may ſee in the figure, a receiver FGE is to be taken, being perforated in the top F, and the tube HI is to be tranſmitted through the hole, that ſo the receiver may be applied to the plate; and then the hole F being ſtopped, and the gage ABCDE being put into the receiver, the air is to be exhauſted; the air then being dilated in the receiver, the mercury cannot be ſuſtained ſo high in the tube HI, but muſt deſcend by degrees; and at the ſame time the air of the tube ED, drives the mercury, by little and little, into the tube AB. When then the mercury in the tube HI deſcends to the height of 29 digits (I take digits for inches throughout all this tract) and ſtays at that height, if we mark to what height the mercury hath aſcended into the tube AB, we may know, that as often as the mercury in our gage ſhall reſt at that height, the air in the ſame receiver will be able to ſuſtain only 29 digits of mercury; ſo that the place in the gage, or in the paper ſemblably divided, muſt be marked with the figure 29. And ſo further, every digit of the deſcent of the mercury in the tube HI may be marked in our mercurial gage, and the part AB will be fit to ſhew all the degrees of the rarefied air.

BUT now if the air be condenſed in the receiver above its wonted preſſure, and all ways of its eſcape be ſtopped, you may immediately know it by the tube ED; for the mercury will be impelled into it by the incumbent air, through the open hole, ſo much the higher, as the compreſſion of the air in the receiver ſhall be the greater; and how great that is, and what an altitude of the mercury it can ſuſtain, may eaſily enough be found out, if the computation be made after the manner following:

IT is evident, from the experiments long ſince publiſhed by Mr. *Boyle*, in his anſwer to *Linus*, that the ſpace poſſeſſed by the air, is diminiſhed in the ſame proportion, as the compreſſing force is increaſed; and *vice verſâ*.

LET then (for example) the ſpace A be poſſeſſed by a certain quantity of air, when (for inſtance) the compreſſing force is F: if now we encreaſe that force by the addition of G. which is equal to it; it will happen, that our ſelf-ſame quantity of air will be reduced to half its ſpace; ſo that B, the remaining ſpace, will be the half of the total ſpace A, even as the former preſſure F is the half of the total preſſure F + G. So further, if we encreaſe the preſſure more, by the addition of H, ſo that the firſt preſſure F is only ⅓ of the total preſſure F + G + H, it will come to paſs, that the air can poſſeſs only the ſpace C, which is ⅓ of the total ſpace A. And ſo afterwards, the remaining ſpace will be in the ſame proportion to the total ſpace, as the firſt preſſure is to the total preſſure. *Fig.* 2.

THE remaining ſpace. The total ſpace::

THE firſt preſſure: the total preſſure.

So that three of thoſe terms or quantities being known, it will be eaſy to find out a fourth, by the rule of proportion. For inſtance, in our gage let the tube ED be the total ſpace, in which the air is compreſſed by the wonted preſſure of the air, which in *England* is wont to be equivalent to 30 digits of mercury, or thereabouts; and therefore the firſt preſſure will be 30 digits of mercury. Now, if that preſſure be encreaſed, and the air be reduced into a narrower ſpace, ſuppoſe into the ſpace NE; if I would find out the quantity of this preſſure, I meaſure the remaining ſpace NE exactly, and I conſtitute that, ſuppoſe ſix digits or inches, for the firſt term of proportion; the ſecond term will be the total ſpace DE, ſuppoſe 12 digits; the third term will be the height of 30 digits of the mercury, which was the firſt preſſure; and ſo the fourth term, or total preſſure will be found to be 60 digits of mercury; whence I may conclude, that the preſſure of the air in the receiver can ſuſtain the mercury to the height of 60 digits: and ſo of the reſt.

FROM the ſame principle before laid down, it will be eaſy to collect, what ought to be the proportion between the largeneſs of the tubes AB and ED. For that depends on the length of the legs, which the higher they are, ſo much the better they can reſtrain and keep in the air, being but a little dilated in the ſealed part. For inſtance, let the length AB be of 10 inches, which height of the mercury is ⅓ of the accuſtomed preſſure, it will be ſufficient, that the tube HB be twice as big as the tube ED; for after the mercury hath aſcended to the top of the tube AB, the air included in the other leg, expanding itſelf into the ſpace, forſaken by the mercury, will poſſeſs three times more than its former ſpace, and ſo $\frac{1}{3}$ of the firſt preſſure, which is 10 digits, will be ſufficient to curb its ſpring. But if the legs were of leſs length, then the mercury would be expelled by the included air, at leaſt in part. And therefore the bigneſs of the tube AB ought to have a greater proportion to the bigneſs of the tube ED, that the aſcending mercury may afford greater place to the air to be dilated, and ſo, the ſpring of the air being weakened, the weight of the mercury cannot be overcome. And that would happen ſo, if the height of the gage be to the height of 30 digits, in the ſame proportion which the firſt ſpace of the air is in, to the total ſpace, which the air would poſſeſs *in vacuo*, according to the principle before laid down.

It is better, that the height of the tube be longer than ſhorter; becauſe if it be ſhorter, the mercury will be expelled in part, and ſo will not be able to ſhew all the degrees of rarefaction; but if it be longer, this only will happen, that the mercury will not reach to the top, and ſo the gage will nevertheleſs indicate all the variations, though they be leſs ſenſible ones.

But the tube DC ought to contain that quantity of mercury, at the leaſt, which may be ſufficient to fill the tube AB, before any way of eruption be opened for the air included in the tube ED. If the capacity of it be much greater, the matter is not much; nor need we be very ſolicitous concerning the figure of this tube.

ICONISME. II.

A deſcription of the engine to compreſs the air.

Fig. 3. AA Is a glaſs veſſel, whoſe orifice is exquiſitely fitted to the plain plate BB.

BB Is a plain plate of braſs, made to cover the veſſel AA exactly.

CC Is a ſmall tube of braſs, paſſing through the middle of the ſaid plate, and faſtened thereunto.

E Is a little valve, opening inwardly, to ſhut the ſmall tube C aforeſaid.

F Is the ſpring depreſſing the valve E.

GGG Is the gnomon faſtened to the plate BB, made for reſtraining the ſpring F.

II Is a ſquare lath, ſuſtaining the plate BB, and bored through in the middle to tranſmit the little tube C.

LLL, LLL Are two iron wires, which paſſing through the holes in the lath II, and compaſſing the upper part of the iron plate KK, do hinder the ſaid plate, that it cannot be much moved from the lath.

KK Is an iron plate, with a hole in the middle, formed into a female-ſcrew, to receive the male-ſcrew MM.

MM Is an iron ſcrew, whoſe uſe is, ſtraitly to conjoin the receiver AA with the plate BB. And leſt the braſs veſſel ſhould be broken, it is convenient to put ſome wood with leather between the ſcrew and the upper part of the receiver: alſo leather is to be put upon the plate BB, both to prevent the breaking of the glaſs, and alſo for the more exact ſhutting of the receiver.

NN Is a pump faſtened to the tube C, below the plate BB.

OO Is the ſucker or plug of the pump NN.

P Is a little hole in the lower part of the pump, by which the air enters into it, when the plug is brought to the loweſt part thereof.

Now if we would compreſs the air by the help of this engine, we put the bodies, about which the experiment is to be made, into the receiver *AA*; and laying it on the plate BB, we firmly bind it thereto by the help of the ſcrew MM. This being done, the ſucker or plug OO is to be drawn, till the external air, by the hole P, can fill all the upper part of the pump: then if the plug be drawn upwards, it will come to paſs, that the air, finding no other way of egreſs, will open the valve E, and enter into the receiver AA, from whence there is no regreſs, becauſe the valve E is preſently depreſſed by the ſpring F, and doth ſhut the hole C. And ſo we may iterate the compreſſion of the air into the veſſel AA, as often as we pleaſe, and the quantity thereof is eaſily known by the mercurial gages.

But I am wont ſo to faſhion the pump, that it may be fitted by a ſcrew to the tube C; for ſo when one receiver is full, we may take away the pump, and uſe it to fill other receivers.

Now, becauſe in theſe engines mercurial gages are uſed only to ſhew the degrees of compreſſion, there is no need of uſing the gages here, which are deſcribed in the firſt figure; for they are made with more difficulty, and beſides, they afford but a ſmall ſpace to note the degrees of compreſſion in. And therefore it is better to fold the glaſs tube, ſealed at one end, in ſeveral places, as the figure T ſhews, that a long tube may be contained in a ſhorter receiver; ſo that the mercury being put in, through the open end, as much as will ſuffice to fill the length of one digit, all the reſt of the ſpace filled with air, will ſerve for the marking of the degrees of compreſſion, much more ſenſibly than can be done in a ſhorter tube.

Here we muſt note, that when the mercury tends downwards in ſuch an inflected gage, the weight thereof doth help the external preſſure; but when it is impelled upwards, the ſame weight makes reſiſtance: this difference muſt be heeded, if we have a mind to try very accurate experiments.

ICONISME. II.

How mixtures may be made in compreſſed air.

Fig. 3. LET the receiver be AA, in which we have a mind to mix either liquors or powders.

Let QQ RR be two tubes, each of them ſealed at one end, and open at the other.

Let RQS be a veſſel of braſs, to be laid upon the orifice of the tubes, as is ſhewed in the figure.

The liquors to be mixed muſt be poured into the tubes QQ RR, each liquor in his own tube, and let the veſſel inverted RQS, be laid on the orifices of the tubes, and in that poſture let all be covered with the receiver AA; let the ſcrew be wrung or ſtraitened, and the air intruded after the manner deſcribed fol. 102. And when you ſhall underſtand by the gage TT, that the compreſſion is arrived at that degree, which you intend, the engine is to be inverted, and ſo the liquors will flow down from the tubes into the veſſel RQS, and be mixed there. If you deſire to mix more liquors or powders, then the number of the tubes is to be encreaſed accordingly.

ICONISME III.

How factitious air may be tranſmitted out of one receiver into another.

I TRIED two ways (principally) to tranſmit air out of one receiver into another; but becauſe the firſt of them ſeemed leſs convenient, I ſhall here only deſcribe the latter.

AA Is a plain plate made of metal, having an hole in the middle.

BB Is the ſtop-cock faſtened to the hole in the middle of the plate AA, one of whoſe ends is formed into a male ſcrew.

DC Is a copper funnel open below, with a broad orifice (that ſo it might be eaſily ſet upon the pneumatick engine, and there ſtand firm) and in the upper part the orifice D is faſhioned into a female-ſcrew, to receive the male-ſcrew of the ſtop-cock BB.

Fig. 2. EE Is a ſmall tube, open at both ends, both whoſe orifices are excavated into a female-ſcrew, to receive the male-ſcrew of the ſtop-cock BB.

Fig. 1. FF Is the receiver laid on the plate AA, and exquiſitely fitted thereunto.

Now, if we would make factitious air, we muſt put the matter, which is to produce the air, into the receiver FF, and placing the ſaid receiver on the plate AA, by means of the ſcrew, we muſt ſtrongly faſten it thereto, after the ſame manner as hath been deſcribed in our engine for compreſſing the air; and the ſtop-cock BB we inſert into the female-ſcrew D; then the orifice C, and with it the receiver, is to be placed upon the pneumatick-engine, and the ſtop-cock B being opened, the air is to be extracted; when the receiver FF is emptied of air, the ſtop-cock B is to be ſhut, that ſo all paſſage of external air into the receiver may be intercluded, and the ſtop-cock being taken out from the female-ſcrew D, the receiver is preſently to be immerged in water, ſo that at leaſt the plate AA, with the ſtop-cock, may be covered therewith; for ſo it will be clear, that no air from without can find ingreſs, and the air produced out of the matter included in the receiver will be preſerved unmixed, and the degrees of its rarefaction or compreſſion are known after the ſame manner, as hath been deſcribed p. 101.

Fig. 3. Now if we would tranſmit that air into another receiver; another receiver FF with another plate AA, and a ſtop-cock BB is to be procured and excavated after the ſame manner, as was before deſcribed; then, by means of the ſmall tube EE, we join the ſtop-cocks BB of both receivers, as is ſhewn in fig. 3, and all ſuſpected places are to be ſtopped with cement or turpentine, that no external air may find admiſſion; then, the ſtop-cocks being opened, the air produced in the former receiver flows into the latter, and the ſtop-cocks being again ſhut and plucked out from the tube EE, the receivers may be kept apart; and if there be any matter included in the latter receiver, we may eaſily view what influence the factitious air hath upon it.

But becauſe the mercurial gages deſcribed fol. 101. are ſpoiled, if they be inverted, and the gages, mentioned fol. 102, do preſently expel their mercury, if the air be rarefied in their receivers; and ſeeing the operation, here deſcribed, cannot be perfected, but both receivers muſt be inverted, and both likewiſe emptied of air; we muſt make gages of another ſort, after the manner following. See fig. 4.

AA Is a glaſs phial filled with mercury to the ſuperficies DD, or thereabout.

BB Is a glaſs tube very well cemented, in the orifice of the phial.

CC Is another tube tranſmitted through the tube BB, and reaching to the bottom of the glaſs. This tube muſt be ſealed above and open below; neither muſt it ſo exactly fill the tube BB, but that paſſage may be opened to the external air within the glaſs AA.

Now if you put this inſtrument into a receiver, from which the air muſt be afterwards extracted, it will come to paſs, that both tubes will be exhauſted of air; and when you invert the receiver, to take in new air, as in fig. 3. is declared, the mercury will flow down to the orifices of the phial, and will be there kept below the orifice of the tube BB; and the new air entring, will eaſily fill both tubes and phial: then the receiver being erected, the mercury will again be ſtagnant in the bottom of the phial, and the orifice of the tube CC will be found demerſed in it. Then if any air be produced out of the bodies included in the ſame receiver, it will come to paſs, that the mercury will aſcend into the tube CC, and there, reducing the air into a narrower place, will ſhew the degrees of compreſſion.

Note, that almoſt all the kinds of factitious air in the beginning are in part deſtroyed, and therefore the degrees of compreſſion cannot here be ſo exactly known, unleſs

leſs we know by experiments, what part of the air is wont to be deſtroyed.

ICONISME IV.

An inſtrument, by which air may be filtrated through water.

Fig. 1. AA IS a glaſs receiver, whoſe orifice, laid upon the plate BB, agrees exquiſitely therewith.

BB Is a plain plate, with an hole in the middle, to tranſmit the tubes CC DD.

CC DD Are two tubes cemented to the plate BB, one of which is no higher than the plate, but the other reacheth almoſt to the top of the receiver.

EEEE Is a ſtop-cock, to whoſe holes the extremities of the tubes CC DD are faſtned.

FF Is the key of the ſtop-cock unperforated, wherein only one chinck GG is excavated.

HH Is the receiver, compaſſing the end of the ſtop-cock, and faſtned to it, ſerving againſt the ingreſs of the outer air, and communicating with the pump II.

LL Is a glaſs veſſel.

M Is a hole in the top of the receiver, whoſe ſtopple is faſtened with a ſcrew.

In the ſecond figure there is exhibited a ſtop-cock, cut tranſverſly, that the two tubes CC DD may be the better diſtinguiſhed, and their inſertion into the ſtop-cock be perceived.

This inſtrument is thus to be uſed: we put the thing, about which the experiment is to be made, into the veſſel; and the receiver AA being laid on the plate BB, we pour water into the hole M till the receiver be half full, or thereabouts, and the veſſel LL, with the matter contained therein, do ſwim on the top thereof; then we ſtop the hole exactly, and faſten it with a ſcrew, in the ſame manner as hath been deſcribed in the firſt ſcheme. Theſe things being thus prepared, the key is to be ſet in that poſture that the chink GG may communicate with the tube CC; then the plug being brought to the loweſt part of the pump, the air of the receiver AA, entering through the upper orifice of the tube CC, will flow down through the chink GG into the receiver HH, and into the pump. Then the key being inverted, ſo that the chink GG do anſwer to the inſertion of the tube DD, the plug is to be impelled upward, and then the air will be expelled from thence, and, finding no other paſſage, will be driven through the chink GG into the tube DD; and from thence will emerge to the upper part through the water ſtagnant in the receiver. Iterating this labour, we ſtrain the air through the water, as often as we pleaſe; and by this means, we know, whether it be cloathed with any new qualities, in reſpect of the body included with it.

ICONISME IV.

How the ſame numerical air may be ſometimes condenſed, ſometimes rarefied.

LET the receiver AA be placed upon the plate BB, and ſcrewed in, as is deſcribed, fol. 102.

CC Is the ſtop-cock, faſtned to the hole in the midſt of the plate BB.

DD Is a pump joined to the ſtop-cock C with a ſcrew.

E Is a veſſel of that bigneſs, that it may fluctuate in the receiver AA without danger of inverſion.

Let ſome animal be put into the veſſel E, and let the receiver AA be put upon it and ſcrewed to it, as the ſcheme ſhews. Then let the pump be filled with water, and by a ſcrew fitted to the ſtop-cock; the ſtop-cock being then opened, let the plug P be forced upwards, then the water aſcending through the ſtop-cock, will, in part, fill the receiver AA, and will reduce the air, contained therein, into a narrower ſpace, without any addition of new air; if then you draw the plug downwards, the ſame numerical air will be again rarefied. Thus you may both condenſe and rarefy the ſame air as often as you pleaſe; and by this means you may find out, whether the condenſation of the air do contribute any thing to prolong the life or health of animals, yea or no?

ICONISME II.

The deſcription of a wind-gun.

Fig. 3. AA IS a copper globe, hollow within.

BB Is a tube, faſtned to the globe.

F Is a valve opening inwardly, and ſhutting the globe BB.

G Is the ſpring depreſſing the foreſaid valve.

H Is a gnomon affixed to the globe AA, and making faſt the ſpring G.

CC Is a tube of iron, faſtned to the tube BB and the globe AA.

DD Is a plug exactly fitted to the foreſaid tube.

EEE Is another plug fitted alſo to the tube BB with an iron wire, reaching almoſt to the valve F.

R Is the protuberance of the tube CC, ſomewhat hollowed above to receive the end of the iron LL.

LL Is a crooked iron, moveable about the extremity in R, ſo that it is like a leaver to lift up the plug EEE.

OPO Is a crooked iron, faſtned in M, that the thumb ſticking in the angle P, the reſt of the fingers may attract the leaver L, and ſo force the plug EEE upwards. But the curvature is made for this uſe, that the one end O might be applied to the ſhoulder, if it be thought fit to aim at any mark.

TT Is a rectangle of iron, compaſſing the leaver LL and the iron OPO, to keep the leaver in that poſture, which the preſent ſcheme holds forth; for otherwiſe the plug EEE, would be thruſt out far away, whilſt we intrude the air into the globe AA.

II Is an elliptic hole, in the upper part of the globe, very well ſhut with a valve, opening inwardly, whoſe uſe is to give liberty of inſpection, and of amending what is amiſs; for the valve may be drawn through the hole by reaſon of its elliptic figure.

SS Is a metalline plate tranſverſly placed above the hole II, and perforated to tranſmit the ſcrew V, by whoſe help the valve ſhutting, the hole II is ſuſtained and is applied cloſely to the hole.

Q Is an hole in the inferior part of the tube CC, by which the air enters into the tube, whilſt the plug D is brought to the loweſt part of the tube.

THE air is thruſt into this engine after this ſort; I tread with my foot upon the crooked end of the plug DD, that it may not be removed from the ground, and I lift the engine upward, till the upper part of the plug be found below the hole Q, and then the air entring through the foreſaid hole, doth wholly fill the tube CC.

THEN I forceably depreſs the engine, and ſo the air, contained in the tube CC, opens the valve F, and is thruſt into the globe AA; whence it cannot return, becauſe the ſaid valves preſently ſtop the paſſage; and thus by iterated turns, we may condenſe the air in the globe, until the force of its ſpring cannot be overcome by our ſtrength.

Now if we would diſcharge the air, ſo condenſed, the plug DD is wholly to be drawn out, and a bullet of lead to be put into the bottom of the tube CC; then by means of the leaver LLL the plug EEE is to be impelled upward, as we ſaid before, and then the extremity of the iron wire opens the valve B, and the air breaking out therefrom, expels the leaden bullet through the tube CC with great violence.

NOTE, that before the plug DD is again put into the tube CC for the compreſſion of the air, about half an ounce of water is to be poured into the ſaid tube. For by this means no air at all can eſcape out by the plug, and moreover, that water exactly filling the upper part of the tube CC, will cauſe, that the whole compreſſed air will be intruded within the cavity AA, and ſo the condenſation will be perfected much ſooner, than if, at every turn, part of the compreſſed air did remain below the valve F.

THIS engine is much better than any wind-guns hitherto mentioned in print.

1. BECAUSE that ſeeing only one valve ſerves, both for the letting in and diſcharging forth of the air, it is leſs ſubject to be ſpoiled or impaired, than if two valves were uſed for that purpoſe.

2. IF any diſorder happen in other guns, the engine remains uſeleſs; but here, by the elliptic hole, a man may take out the ſpring and the valve, and ſo mend whatſoever is amiſs.

3. IN other guns, the valves being covered with leather were put in before the engine was on every ſide ſhut, and therefore ſilver-ſoder could not be uſed in cementing the parts, but only lead-ſoder, by which the air, being much compreſſed, could by no means be reſtrained; but here all things are well cemented with ſilver-ſoder, without danger of burning, in regard the valve covered with leather is put in afterward through the elliptic hole II.

4. BUT this engine is chiefly to be preferred before others on this account, becauſe we emit ſeveral bodies into the receiver, through the elliptic hole, and ſo make many experiments in highly compreſſed air.

ICONISME V.

An inſtrument to diſtill in vacuo.

Fig. 1.

AA IS a braſs veſſel, ſhut below and open above.

BB Is a diaphragma or midriff of tin, whoſe edges are ſo poliſhed on both ſides, that they exquiſitely do agree and ſuit with the edges of the veſſels AA DD, which are alſo poliſhed, and ſo keep the external air from ingreſs.

CC Is a tube faſtened to a hole in the middle of the diaphragma BB.

DD Is a braſs veſſel, whoſe aperture is applied to the diaphragma BB.

EE Is a ſtop-cock faſtned to the hole of the diaphragma BB.

FF Is a tube reaching from the ſtop-cock EE to the hole for ſuction in the pneumatic engine.

GG Is a metalline veſſel ſhutting in the commiſſures of the veſſels with the diaphragma, and alſo the ſtop-cock, that it, being filled with water, may keep all ſafe from the external air. This veſſel is to be ſodred to the veſſel AA.

WE uſe this engine after the following manner: taking away the diaphragma BB, we put the things to be boiled into the veſſel AA, and ſo ſet it in a convenient place, that it be not ſhaken, whilſt it is evacuated; then putting on the diaphragma BB and the veſſel DD, we put to the pneumatic engine, and making uſe of the tube FF, the air is pumped out of the veſſels, the veſſel GG being yet firſt filled with water. Then the ſtop-cock is to be ſhut, and taking away the tube FF, we may place the evacuated engine on the fire, and the vapours aſcending through the tube CC, are condenſed in the upper veſſel, and ſo we have a liquor diſtilled *in vacuo*; and the quantity of the generated air, is known by the mercurial gage H, but that muſt be kept up in the top of the receiver, leſt the mercury do exhale, by reaſon of too much heat.

Note, that round pieces of paper, perforated in the middle, are to be laid over the orifices of the veſſels AA DD, to the end they may be better joined with the diaphragma; and the commiſſures of the tube FF with the ſtop-cock and pneumatic engine are to be fortified with cement, and the ſtop-cock EE is ſo to be diſpoſed with the veſſel GG, that part of the key may be prominent without the veſſel through the hole, that ſo it may conveniently be turned, and yet nevertheleſs, the ſtop-cock, with the diaphragma, may be taken out of the veſſel GG, whilſt the veſſel AA is to be filled with fleſh or any other matter. And that is very eaſily done in this manner: the key conſiſts of two parts, one of which M is turned in the ſtop-cock itſelf, by means of a certain chink, which receives the ſmall protuberance of the other part OO, which other part doth exactly fill the ſmall pipe NN, faſtned to the veſſel GG, and being prominent outwardly may eaſily be turned in it, and communicate its motions to the other part M, but it is drawn outward whilſt the diaphragma BB is to be taken out of the veſſel GG.

Fig.2. Shews you another inſtrument, herein differing from the former, that it is almoſt all of glaſs, and affords a longer paſſage for the vapours.

BB Is not a diaphragma, but only a ſmall tube, poliſhed at both ends, that it may exquiſitely ſuit with the orifices of the veſſels A and D.

AA DD Are two glaſs veſſels, whoſe orifices are applied to the tube BB, and ſo the vapours are eaſily tranſmitted from the one to the other.

EE FF GG I, have the ſame uſe as in the former ſcheme, and the whole inſtrument is to be evacuated after the ſame manner, and placed upon the fire; except, that here the veſſel AA, as being made of glaſs, muſt not be put on an open fire, but *in balneo Mariæ*, or on ſand, and the vapours will be condenſed in the veſſel DD.

ARTICLE I.

Several ways uſed to help the production of the air.

Experiment I.

July 11, 1676. Becauſe it appears by the new experiments publiſhed at *Paris*, in the year 1674, and which are to be ſold by *John Caſſon* in St. *James's-ſtreet*, that bread alone can produce no air *in vacuo*, we were willing to try, whether yet it did not contain ſome air, which might come forth ſome other way. I therefore included a little piece of bread, very moiſt, and a little kneaded, *in vacuo* with a mercurial gage.

July 12. In ſix hours ſpace no air was produced yeſterday, but this night a little brake into the receiver, as much as did ſuffice to ſuſtain three digits of mercury; the reaſon was, becauſe I had neglected to fortify the cover with turpentine.

Towards the evening, I found the mercury higher, by one inch, or thereabout, and I am very certain, that nothing had entered from without.

July 13. This night alſo the mercury aſcended higher, but my gage was not of that ſort, as exactly to diſcover many degrees.

July 26. This day the piece of bread disjoined its receiver from the cover, by the force of the produced air, and the ſmell of it was acid.

Hence it follows, that water is a fit diſſolvent to draw forth air out of bread.

Experiment II.

July 11. I tried another way to extract air from bread, for by the help of a burning glaſs I burnt bread *in vacuo*, and ſo I found, that the bread did generate much air, and that air did ever and anon break out, as by fulmination: whence it ſeems probable, that air is contained in bread, but it is ſo cloſely coarctated therein, that no eaſy operation can give it a diſcharge; but if any thing could diſſolve and looſe that knot, it may then produce great effects.

Experiment III.

Sept. 22. I took eight ounces of dried grapes, and, with ſeven ounces of water, included them in a receiver, able to hold 22 ounces of water; the grapes were bruiſed.

Sept. 23. The receiver was demerſed under the water all this night, yet the mercury aſcended two whole inches.

Sept. 30. In ſeven days ſpace, the mercury came to the height of thirteen inches.

Octob. 5. In five days ſpace, the mercury ran up twelve inches, and was now 25 inches high.

Octob. 18. The mercury did not proceed to aſcend with the ſame ſwiftneſs, and the air began to paſs out of the receiver, but not before this day; yet theſe grapes produced much more air than thoſe, which I had included without water. See *Art*. IX. *Exper*. I.

Experiment IV.

July 12. I included of raiſins of the ſun bruiſed ten ounces *in vacuo*, with a ſufficient quantity of water to promote fermentation.

July 14. In two days ſpace the raiſins had produced ten inches of air.

About the evening the mercury was about fifteen inches high: the fifteenth day, the mercury had almoſt reached to its accuſtomed height.

July 16. This day, in the morning, I found the receiver ſevered from its cover, and the air breaking forth through the water, in which it was demerged: I included the ſame raiſins again *in vacuo*.

July 18. This day, in the morning, I found the air again breaking out.

July 19. I shut up the ſame raiſins in the ſame empty receiver.

July 21. This day I found the receiver full, and the air breaking out of it.

I again ſhut in the ſame raiſins in the ſame exhauſted receiver.

July 23. Yesterday, about noon, I found the whole receiver almoſt full of air, and this day in the morning I perceived the air to paſs out very often. From the firſt experiment of art. IX. it appears, that grapes, without water, can generate but little air: ſo that it is manifeſt hereby, that water is a fit medium to elicit air out of them: it is alſo evident, that the production of air is not begun preſently upon the affuſion of water; but it proceeds on with greater ſwiftneſs, after that the parts of the water in five or ſix days time have more deeply ſunk into, and pervaded the grapes.

Experiment V.

Aug. 13, 1677. I included pears in two receivers *in vacuo*; and plums in another.

Aug. 16. In three days ſpace all my receivers were filled with air, newly generated; yea, one of them, which included the pears, becauſe I had left it expoſed to the rays of the ſun, in the ſpace of 24 hours, was ſeparated from its cover; whence we may conjecture, that the production of air is very much promoted by the heat of the ſun.

Experiment VI.

Octob. 16. 1677. I took two ounces of grapes bruiſed, and ſecured them from the ingreſs of air, in an exhauſted receiver capable of containing twenty ounces of water.

Octob. 17. The mercury roſe higher about one half inch.

Octob. 18. These laſt 24 hours the mercury ran up about another half inch.

Octob. 20. The height of the mercury was two inches.

The 22 it was almoſt 4.

The 27 it was almoſt 6 inches.

Jan. 2, 1678. The mercury, as yet, came not to the height of 10 inches.

Octob. 16, 1677. I put three ounces of bruiſed grapes, with half an ounce of ſpirit of wine, into a receiver able to hold 30 ounces of water, and then I exhauſted the air.

Octob. 17. The mercury aſcended, but a very little.

Octob. 18. The mercury came not up to the height of one quarter of an inch.

Octob. 20. The mercurial gage was out of order.

Jan. 2, 1678. I this day found my receiver filled with air, and alſo, when ſome of the liquor was poured out, ſome bubbles were formed in the turpentine about the orifice, and were broke outwardly.

From this experiment, made in two receivers together, it ſeems to follow, that ſpirit of wine doth much advance the production of air *in vacuo*, though in common air it wholly hinders it. See the IId, VIIIth, and XIVth experiments of the IId article.

Experiment VII.

July 19, 1678. I put muſt, expreſſed from grapes bruiſed, and kept for 10 months in a veſſel ſtopt with a ſcrew, into the ſame receiver, being alſo ſtopped with a ſcrew.

July 21. The mercury had not aſcended at all.

23. The height of it was 3.

24. The height was 5.

25. In the morning it was 104.

Towards the evening the height was 137; and the muſt got out.

26. The muſt was almoſt all got out of the receiver; and although the air now did poſſeſs double the ſpace it did yeſterday, yet it kept up the mercury in the ſame height.

27. About half of the remaining muſt brake forth this night, becauſe I had omitted to ſet the ſcrew, leſt the receiver ſhould have been broken in pieces.

From this experiment it follows, that grapes kept ſo long a time do rather acquire than loſe a fermentative virtue.

Experiment VIII.

Jan. 30. I put two quantities of apples, boiled the day before, into two receivers ſtopped with a ſcrew; with one of them I mixed one third part of ſugar, the other had no ſugar at all.

N. All theſe receivers were quite full.

Jan. 31. I included raw apples bruiſed in three receivers; in one of them I mixed one third part of ſugar; the ſecond was without ſugar, and ſo was the third, but it differed herein from the ſecond, that it was ſix times as big: for by this means, we may know, whether the capacity of the veſſel, or the mixing of ſugar, or the crudity of the fruit, can promote or retard the production of air.

Feb. 10. In that receiver only, which contained the raw apples with ſugar, ſome air was produced.

Feb. 14. The raw apples with ſugar had impelled the mercury up to 30 inches; thoſe that were boiled with ſugar, to two only; in the other receivers no air was produced.

Feb. 18. In the receiver containing the raw apples with ſugar, the mercury came to the height of 56 inches; in that containing the boiled apples with ſugar, the height was three; in the other receivers there was alſo ſome air produced, except in that wherein the boiled apples without ſugar were put. I opened that receiver in which the apples had produced ſo great a quantity of air; yet the apples ſeemed hardly to be fermented, but were endued with a moſt pleaſant taſte.

Feb. 21. The boiled apples without ſugar had loſt ſome of their juice; and, opening the receiver, I found the cover to be broke, and yet the apples were not rotten at all.

March 1. In the great receiver, containing the raw apples, the mercury was 25 inches high; in the little one, only 7; but in that where the apples were boiled with ſugar, the mercury had aſcended to 9 inches.

March 8. In the great receiver the height of the mercury was 29; in. the leſſer 22½; and where the boiled apples with ſugar were, the altitude abode at 9 digits.

March 17. The juice got out of the great receiver; in the little one the height was 67; where the apples were boiled with ſugar, it was 15 digits.

From this experiment it ſeems inferrable, that ſugar, the crudity of the fruit, and the largeneſs of the receiver, do all contribute to the production of air.

ARTICLE II.

Several ways to hinder the production of air.

Experiment I.

Dec. 21, 1678. I made paſte of bread-corn-meal, without leaven, and put it into an empty receiver; and then I put the receiver in a certain apartment, with fire, which there kept a greater heat than is wont to be in the middle of ſummer; yet the dough or paſte produced no air in 10 hours ſpace: whence it ſeems to follow, that if dough hath once ſuffered too much cold, it can ſcarce recover its faculty of fermenting; for, ſome years ago, when I made dough without leaven in the ſummer time, it produced very much air *in vacuo* in a ſhort time.

Experiment II.

May 23. I included three ounces of dough, kneaded with leaven, in a receiver capable of holding 50 ounces of water; I alſo poured upon it ſome quantity of ſpirit of wine, to try whether fermentation would be hindred by that means.

May 24. The mercury was three inches high.

26. Little change.

27. No change.

29. No change.

June 2. It ſeemed to have aſcended a little higher.

14. No change.

Dec. 14. No more air being produced from the dough, I took it out from the receiver, and found the ſmell of it not grateful, but ſubacid: I put it into an empty receiver, and there it roſe or ſwelled to double its accuſtomed ſpace, and made a little ebullition.

May 23. I included three ounces of dough kneaded with leaven in a receiver able to hold 50 ounces of water, but here I mixed no ſpirit of wine.

May 24. The mercury was $19\frac{1}{2}$ inches high.

May 26. It was 38 inches high.

27. There was no change.

Decem. 14. The mercury perſiſted in the ſame height; and this day, opening the receiver, I found the dough of a moſt acid ſmell.

From which experiment it ſeems to follow, that ſpirit of wine, even in dough kneaded with leaven, doth hinder the production of air.

Experiment III.

Aug. 29. I included pears, with a mercurial gage, in a receiver full of water, and then I intruded air into it, till the mercury ſtaid at 26 inches higher than it was wont; within a quarter of an hour one of the pears was broken, and afterwards almoſt all of it was reduced to the conſiſtence of a pultis.

Aug. 30. In 24 hours ſpace, the pears ſeemed to have afforded no air; but on the contrary, the mercury in the gage was depreſſed an inch and half.

Aug. 31. I this day found no change in the height of the mercury.

Sept. 1. Now the pears began to produce air, and the mercury was almoſt 27 digits high.

Sept. 2. In 24 hours the mercury aſcended more than eight digits, and now it was 35 digits high.

Sept. 3. The height of the mercury was increaſed 17 digits, ſo that now it was 52 digits high or thereabout.

Sept. 4. Within thoſe 24 hours the mercury roſe ſeven digits higher, and reſted then in 59.

Sept. 5. It was 64 digits high; a pear being broken, was become black.

Sept. 6. Three digits and more being added to the height of the mercury, it came now to the 67 digits and ½ beyond what it was accuſtomed.

Sept. 7. It deſcended three digits, and reſted again in 64.

Sept. 8. This day the mercury was depreſſed to the 58th digit, and ſome of the water had broke out; and therefore I ſtraitned or ſet the receiver with a ſcrew.

Sept. 9. The mercury aſcended full three digits, and now ſtuck ſuſpended above 67.

Sept. 10. In 24 hours it mounted $1\frac{1}{2}$, and ſtopped almoſt in 69.

Sept. 11. Now it began to deſcend again, and was no higher than 67 digits; yet I am certain, nothing had eſcaped out of the receiver, but it was a ſharp cold night.

Sept. 12. No change did evene.

Sept. 13. The height of the mercury did again decreaſe; it was not above 64 digits: the cold increaſed.

Sept. 14. In 24 hours it became higher by ſix digits, reaching to 70.

Sept. 16. It was 69 digits high, or thereabouts.

19. It remained in the ſame place.

20. It again reached to 71.

Sept. 23. The mercury was again depreſſed to 69.

Octob. 1. It came now to the height of 75 digits.

Octob. 3. Yesterday I found no change at all in the mercury; but this day it ſtuck in 70; and the cold was very bitter.

Octob. 5. Yesterday the mercury did abide in the ſame place; but this day it reached to 75: it was a rainy day.

Octob. 7. It continued rainy; and the mercury continued in the ſame place.

Octob. 10. Hitherto the mercury was not changed; but this day I found it had deſcended to 69 digits; though the rain ceaſed not.

Octob. 12. Yesterday the mercury ſtood ſtill; but this day it was depreſſed to 65 digits: and the cold weather returned.

Octob. 13. The height of the mercury was 64.

14.	The height was	69.
15.		74.

24. The height was 68. It was a cold ſeaſon.

Nov. 2. The height was 64. The cold encreaſed.

5. The height was 80½. The cold abated.

2. The height was 65. It was a hard froſt,

27. The height was 68. It was a thaw.

Dec. 6. The height was 61. It was a very bitter froſt.

From the former experiment we may learn, that fruits in a great compreſſion of the air, cannot produce ſo great a quantity of air; for when I made an eſtimate of the quantity of the fruits, and of the ſmall ſpace which is to be filled with air; I found, that that quantity of air was not $\frac{1}{8}$ part of that, which had been produced in an empty and a large receiver; yet the cold of the water might alſo give ſome impediment to the generation thereof, as the following experiment will confirm.

It is alſo farther manifeſt, that the air is produced by iterated turns, and, as it were, by reciprocations, even as all bodies in motion, by the force of their gravity or of their ſpring, are carried beyond their point of reſt, and ſo ſuffer many vibrations, or goings and returnings. Now although cold and heat are not the ſole cauſes of ſuch reciprocations, yet they ſeem to contribute much thereunto.

Experiment IV.

Feb. 22, 1677. I included 10 ounces of paſte in a receiver capable of holding 22 ounces of water, and afterward I thruſt as much air into it as was ſufficient to ſuſtain 73 digits of mercury, beſides the wonted preſſure. In two hours ſpace I perceived no ſenſible change.

Feb. 23. In 18 whole hours the mercury ran up ſeven digits only, its height being 80.

In ſix hours ſpace it was now aſcended three digits; its height was 83.

Febr. 24.	Its height was	90
25.		97
26.		101
27.		105
28.		107½
March 1.		112

And water ſeemed to be expreſſed out of the maſs.

March 2.	Its height was	120
3.		121

4, & 5. It ſtayed at 121

March 8. These two or three laſt days, the froſt being diſſolved, the mercury ran up four digits: the height thereof was 125.

March 10. Yesterday the mercury perſiſted in the ſame height; but this day, mounting ſix digits, it ſtayed in 131.

March 21. By reaſon of the long cold ſeaſon, no air was produced; but in the three laſt days the mercury aſcended ſeven digits, and ſtayed in 138.

April 4. Yesterday I perceived the mercury had aſcended, but I deferred exactly to meaſure the quantity till this day: but in this very night one of the iron-wires, that ſtraitned the receiver, was broken, and ſo the receiver was ejected to 4 or five foot diſtance.

From this experiment we may conjecture, that the compreſſion of the air did very much hinder the production thereof; for that is wont to be perfected in paſte in two or three days ſpace. Moreover, cold doth much hinder the ſame production.

Experiment V.

March 1, 1677. I included two ounces of raiſins of the ſun, with ſix ounces of vinegar, in an emptied receiver, and bubbles in a ſufficient quantity did break forth: the raiſins were bruiſed.

March 2. The mercury in 24 hours ſpace aſcended not to the height of half a digit: yet ſome bubbles ſtill appeared.

March 25. The vinegar did always appear interſperſed amongſt ſome of the bubbles, yet the mercury aſcended not to the height of one digit.

By this experiment it appears, that vinegar doth hinder the production of air and fermentation, ſeeing otherwiſe raiſins are wont to afford much air.

Experiment VI.

April 7. I included 10 ounces of paſte in a receiver capable of holding 22 ounces of water: afterwards I intruded air into it, as much as ſufficed to ſuſtain 128 digits of mercury, beſides its accuſtomed height.

In ſix hours ſpace the mercury mounted up four digits, and ſtaid in 132.

April 8. In 16 hours the mercury ran up nine digits higher: it ſtaid in 141.

Nine hours after the mercury was not changed.

April 9. This day, in the morning, I perceived ſome air had broke forth, and the mercury was depreſſed to 130 digits, and therefore with a ſcrew I ſhut the receiver more cloſely, and thruſt in 11 digits of new air: the height was 141.

April 10.	The height was	151
11.		158
12.		168
13.		176
14.		183
15.		183
16.		187
17.		191

April 27. For eight whole days the mercury kept its ſtation in the ſame place, but theſe two laſt days it aſcended ſeven digits, and ſtayed in 198 above its wonted height.

April 30. Perceiving the mercury to perſiſt in the ſame height, I a little relaxed or eaſed the ſcrew, that ſome air might break forth; and when I ſaw, that the mercury had ſo far deſcended, that it exceeded its accuſtomed height only 50 digits, I preſently ſet the ſcrew, that ſo I might know, whether that remiſſion of the ſpring of the air would afford any place for new air to be generated; and truly in two or three minutes time I found the mercury to have aſcended ſenſibly higher.

Three hours after, making an admeaſurement, the mercury was found 12 digits higher; for it came to 62.

In five hours ſpace it aſcended one digit and ½ and no more.

May 1. In 15 hours the mercury gat higher only one digit.

May 3. Yesterday the mercury perſiſted in the ſame height, but this day it was higher by 1½, and remained in 66.

May 4. The mercury was not changed at all, and therefore I ſuffered all the air to eſcape; but ſomething hindered, that I could not quickly ſet the ſcrew; whence it is probable, that very much air, which at that time was produced, got out of the receiver; yet nevertheleſs, after the receiver was again ſtraitly ſtopped, I perceived, that two digits of air and more had been produced in five or ſix minutes time.

May 7. The mercury, in three days, again mounted two digits.

May 8. The mercury was higher by ½ a digit.

May 11. Those two laſt days the mercury again ran up half a digit, and not much more. I included this maſs, almoſt unfit, as it ſeemed, for producing of air *in vacuo*; and then, in five minutes ſpace, the mercury aſcended to the height of one digit.

May 21. It did not yet aſcend quite three digits.

May 30. The mercury ſtaid at the height of four digits and ½.

By this experiment it appears, that all the air, producible from paſte, may be in a manner generated in a great compreſſion; yet it is ſomewhat reſtrained by that hindrance, which at length, in a leſſer compreſſion, will break forth in a ſhort time.

Moreover, we have a confirmation by this experiment, that air is producible by repeated turns and operations; alſo, that it is produced more ſlowly in compreſſed than in free air: for ſuch a production, in free air, is wont to be perfected in two or three days time.

Experiment VII.

Artificial air.

July 30, 1677. I included plums and apricocks, many of them being cut aſunder, in an empty receiver, and afterwards I immitted as much air, produced out of cherries, into the ſame receiver, as was ſufficient to ſuſtain 64 digits of mercury.

Aug. 1. Our fruits had produced no air, but grew yellow, by reaſon of their overmuch ripeneſs, more than thoſe which were in common air. *See* p. 111.

Aug. 3. This day I found the mercury a little higher, and that apricock, which remained whole, ſeemed to be full of ſome drops of water.

Aug. 7. The whole apricock grew more and more ſoft; the mercury was 59 digits high above its wonted preſſure.

Aug. 8.	The height of it was	61
9.		65
10.		71
11.		74
13.		78
14.		80
15.		80

16. and the days following it abode at the ſame height.

24. The height of it was 77; though I certainly knew, that nothing had iſſued or eſcaped out of the receiver.

29. Seeing I found, that neither the fruits nor the height of the mercury were changed any more, I opened the receiver, and perceived, that the apricocks had kept their colour very well, but the fleſh of them was ſpungeous, and their taſte ſubacid; many bubbles had broke forth from them, at the time they were freed from the circumſtant preſſure.

Common air.

July 30, 1677. I included the half parts, cut off from the fruits aforeſaid, in a receiver full of common air; and with them alſo ſome fruits of the ſame kind uncut.

July 31. I found the mercury had attained eight digits high.

Aug. 1. At ſix o' clock in the evening the mercury was 21 digits high; in the other receiver it was not moved.

Aug. 3. Our fruits kept their firmneſs much better than thoſe, which were included with artificial air. The height of the mercury was 35 digits.

Aug. 4. The height of the mercury was 42 digits.

Aug. 6. Our whole apricock ſeemed not at all to be altered. The height of the mercury was 57.

Aug. 7.	The height of it was	81
8.		95
9.		113
10.		124

The colour of the whole apricock yeſterday began, and now proceeded, to wax yellow. No moiſture appeared.

Aug. 11.	The height of it was	131
13.		157
14.		163
15.		171
16.		171

17. and the days following the ſame height remained.

27. The height was 182.

29. When I ſaw, that neither the fruit nor the height of the mercury were changed any more, I opened the receiver, and found the apricocks of a more acid and leſs acceptable taſte, than the others in factitious air; yea, their pulp was of a very good colour, but ſpungy: they ſent forth many bubbles, as the others did.

From this experiment made in two receivers together, it is probably collected, that the artificial air of the cherries was a great hindrance to the apricocks, that they could not produce air; yet, notwithſtanding, it doth advance the alteration of their colour and firmneſs; and is alſo good to preſerve their taſte.

EXPERIMENT VIII.

Grapes without ſpirit of wine.

Octob. 10, 1677. I shut in an ounce and half of grapes, unripe and bruiſed, in a receiver, that would hold 10 ounces of water; I drew out no air.

Octob. 11. The mercury aſcended a little.
12. There was but a ſmall change.
13. The height was ½ a digit.
17. The height was one digit.
18. The height 1½.
19. The height almoſt four digits.
20. The height the ſame, but ſome finew or mouldineſs appeared in their ſuperficies.
21. The height was 4½.
22. 23. 24. The height remained the ſame, but the mouldineſs or finew encreaſed.

26.	The height of it was	5½
27.		6
30.		6½
Nov. 2.		7½
6.		9
8.		10

Nov. 9.	The height of it was	12
12.		15
14.		17
18.		23
21.		26
Dec. 8.		36½
12.		39
27.		39

Jan. 6, 1678. The height was 36. The air broke out.

Grapes with ſpirit of wine.

Octob. 16, 1677. I made the ſame experiment in another receiver, obſerving the ſame circumſtances, ſave that here I mixed two drachms of ſpirit of wine with the grapes.

Octob. 11. The mercury was not changed.
12. There was no change.
13. The mercury was not moved.
17. It aſcended a little.
18. The height of it was not yet a quarter of an inch.
19. It was moved but a very little.

Jan. 6. The grapes, during all the time elapſed, had produced no air.

By this experiment made in a double receiver, it appears, that ſpirit of wine doth hinder fermentation.

EXPERIMENT IX.

Octob. 17, 1677. I put one peach into an emptied receiver, with ſome quantity of ſpirit of wine, which yet could not touch the peach, unleſs it were elevated into vapours.

March 27, 1678. I drew out the peach, which had kept its colour, only it had loſt its firmneſs. Though the receiver was but ſmall, yet it was not filled with air, for when it was opened, the air ſeemed to ruſh into it: the peach being ſoftned, was ſo depreſſed, that the lower part of it did a little touch the ſpirit of wine; it alſo came to paſs, that the ſuperior part had contracted the taſte of the ſpirit of wine, as well as that, which was immerged in it.

EXPERIMENT X.

Air with ſpirit of wine.

Octob. 17. I included five peaches in an exhauſted receiver, and together with them, ſome ſpirit of wine, which could not touch the peaches, unleſs it were elevated in form of vapours.

Octob. 18. The mercury aſcended not at all.
20. The height of the mercury was 3½.

21.	The height of it was	5½
22.		7½
23.		9
26.		9½
Nov. 2.		12
6.		14
12.		16

Nov.

Nov.	14.	It kept the ſame height.	
	16.		
Dec.	8.	The height of it was	18
	16.		19 ½
	27.		20 ½

Jan. 6, 1678. It was 23.
March 28, 1678. It was 31 ½.

Air without ſpirit of wine.

Octob. 17. I INCLUDED five peaches in a receiver full of common air, without ſpirit of wine.

Octob. 18. The mercury aſcended not at all.

20. The height of the mercury was five digits.

	21.	The height of it was	8
	22.		10
	23.		11
	26.		12
Nov.	2.		15
	6.		17 ½
	12.		20
	14.		20
	16.		21
Dec.	8.		26
	16.		26 ½
	27.		28 ½

Jan. 6, 1678. The height was 32.
March 28, 1678. The height was 33 ½.

April 15. THE liquor in the lower part of the receiver had broke all out, and the air followed it; ſo that I took out the peaches.

BY this experiment we learn, that the very vapours of ſpirit of wine do ſomewhat hinder fermentation, yet much leſs than the ſpirit itſelf.

EXPERIMENT XI.

Paſte with leaven or ferment.

April. 27, 1678. I INCLUDED an ounce and half of paſte mixed with leaven, with common air, in a receiver able to hold 23 ounces and half of water.

April 28. The height of the mercury in the gage was 2 ½.

April 30. The height of it was 3 ¾.

May 4. The mercury was depreſſed, though no air broke forth, and the paſte was mouldy. The height of it was 2 ½.

May	6.	The height of it was	2 ¾
	8.		3
	10.		3 ½
	14.		4
	17.		4 ½
	20.		5
	24.		6
	28.		8
June	2.		9
	6.		10
	14.		10 ½
July	5.		13 ½
	19.		15

Paſte without leaven.

April 27, 1678. I INCLUDED an ounce and half of paſte, without leaven, with common air, in a receiver capable of holding 23 ounces and a half of water.

April 29. HITHERTO the mercury had not aſcended; but this afternoon I found its height to be a quarter of a digit.

April 30. There was no change.

May 4. The mercury aſcended but very ſlowly, and the paſte was finewed or mouldy.

May 6. The height of the mercury was four digits.

	8.	The height of it was	5 ½
	10.		7 ½
	14.		10 ½
	17.		12 ½
	20.		13 ½
	24.		16
	28.		18 ½
June	2.		20 ½
	6.		21 ½
	14.		25

BY this experiment, made in two receivers at once, it ſeems clear, that leaven doth rather hinder than help the production of air, if the paſte be not made in a place hot enough.

EXPERIMENT XII.

Paſte with ſpirit of wine.

May 23. I INCLUDED an ounce and a half of paſte, without leaven, in a receiver capable of holding 25 ounces of water, and I poured ſpirit of wine on the paſte.

May 24. The mercury was one digit high.
26. It was almoſt two digits high.
27. It was 2 ½.
31. There was no change.

June	2.	The height of it was	3 ½
	6.		4
	10.		4 ½

July 19. No change.

Decem. 14. WHEN the height of the mercury was no more changed, I opened the receiver, and the paſte affected my noſtrils with a ſubacid ſmell.

Paſte without ſpirit of wine.

May 23. I INCLUDED one ounce and a half of paſte, without leaven, in a receiver capable of holding 25 ounces of water; but I added no ſpirit of wine.

May 24. There was no aſcenſion of the mercury.

May 26. It was three digits high.

	27.	The height of it was	4 ½
	28.		5 ½
	29.		7
	31.		9 ½
June	2.		12
	6.		17
	10.		22
July	4.		30

July 19. The mercury little exceeded 30 digits. This day I found, that the air had broke out, and therefore I ſet or ſtraitned the ſcrew.

Decem. 14. THE mercury came again to the height of 15 digits; but this day I opened the receiver, and found the paſte very acid.

FROM theſe experiments, made with paſte, in a four-fold receiver, at one and the ſame time, it ſeems to follow, that ſpirit of wine doth very much prejudice the production of air; and the rather, if the paſte be wrought with ferment: beſides, it is clear, that paſte without ferment, in tract of time, will produce no leſs air than paſte with ferment.

EXPERIMENT XIII.

Octob. 11. I INCLUDED new ale in a receiver, exactly filled by the help of my pneumatick engine, that ſo no air might be left; and I included another quantity of the ſame ale in another receiver, wherein ſome room was allowed for the air.

Octob. 12. I THIS day found the cover of that receiver, in which I had left ſome air, to be broken, and therefore I transfuſed the ſame ale into another receiver, in which there was room large enough left for the air. In the receiver exactly full, the mercury aſcended a little.

Octob. 13. IN the receiver exactly filled, the height of the mercury was 12 digits; in the other receiver 13 digits, though it had been ſhut up a ſhorter time, and a much larger ſpace was left therein, in which the air newly produced might have been dilated.

Octob. 14. IN the full receiver the height was 13; in the other receiver, 18. Towards evening I found the full receiver to work with greater ſwiftneſs, for the height of the mercury in it was 22; and in the other 20.

Octob. 15. IN the full receiver the height of the mercury was 42 digits; in the other 26. Beſides we muſt mark, that ſome bubbles of air, which in the full receiver had poſſeſſed its upper part, now did wholly vaniſh; and beſides, the ale did occupy a long ſpace in the mercurial gage, wherein before it was not found.

Octob. 16. IN the full receiver the height was 60 digits. In the other 30.
18. IN the full receiver the height was 90. In the other 40.
22. IN the full receiver the height was 90. In the other 42.
23. IN the full receiver the height was 108. In the other 50.
26. IN the full receiver the height was 108. In the other 60.
28. IN the full receiver the height was 133. In the other 63.

THE bubbles, which were vaniſhed, appeared again, yet nothing flowed out.

Nov. 8. THE full receiver had loſt much ale: wherefore I opened it, and thereupon all the ale ſeemed as if it would have vaniſhed into froth, unleſs I had ſuddenly ſhut the little hole, which I had opened: I tried it many times, that if the hole were opened in the gage, the mercury preſently deſcended; but if the hole were again ſhut, it would ſpeedily aſcend; as if the compreſſion, being abated, had afforded ſome facility for the production of air. The ale had a moſt pungent taſte.

Nov. 9. I OPENED the other receiver, and obſerved in a manner the ſame circumſtances.

FROM this experiment it ſeems to follow, that ale, if the air be wholly excluded from the veſſel, will ferment more ſlowly, than if ſome air were left with it: yet, in tract of time, it makes a greater compreſſion, if no place be left for its dilatation.

EXPERIMENT XIV.

Peaſe with ſpirit of wine.

June 27. I PUT green peaſe into an emptied receiver with ſpirit of wine. Towards the evening the receiver ſeemed to admit the external air, and the mercury came to the height of 18 digits; and therefore I firmed the cover with turpentine.

June 30. I PERCEIVED no more change in the height of the mercury.

July 7. No air was produced, even in the moſt vehement heat.

Peaſe without ſpirit of wine.

June 27. I PUT new peaſe into an emptied receiver without ſpirit of wine. The receiver and the quantity of the peaſe were the ſame, as in the laſt mentioned experiment.

June 28. THE receiver was full of air, for I think it was not exactly ſhut; and therefore I again included the ſame peaſe. Towards evening the height of the mercury was five digits.

June 29.	The height of it was	10
30.		16
July 1.		19
6.		26
7.		30

July 8. THE air got out of the receiver being too much filled.

FROM this experiment, made in two receivers at once, it appears, that ſpirit of wine doth alſo hinder the production of air in peaſe.

ARTICLE III.

The effects of artificial air are different from the effects of common air.

EXPERIMENT I.

June 19, 1677. I PUT cherries into an evacuated receiver. In ſix hours time the mercury came to the height of five digits and a half.

June 20. The aſcenſion of the mercury was 5 ½. Towards the evening it was two.

N. The aſcenſions are always to be underſtood, as added to the former.

June 21.
22.
23.
24.
25.
26.
27.
28.
30.
July 1.
2.
3.
4.
5.

The aſcenſion was
½
½
2
1 ½
1 ½
3
3
3
5
1 ½
3
4
2
2 ½
3

The height was 48 ½ but I tranſmitted the air into another receiver, and the mercury was depreſſed to the height of 35 digits.

July 6. The aſcenſion of the mercury was four digits in one night's ſpace.

7. The aſcenſion of it was 5 ½ in 24 hours ſpace.

8. The aſcenſion of it was 5.

9. The aſcenſion of it was 5.

10. The aſcenſion of it was 6.

11. The aſcenſion of it was 12 in the ſpace of 34 hours.

12. The aſcenſion of it was 7.

13. The aſcenſion of the mercury was three, the height about 92 digits; but the air being tranſmitted into another receiver, the mercury ſtaid in the height 50.

14.
15.
16.
17.

The aſcenſion was
14
11
13
5

18. The aſcenſion of the mercury was nine, the height of it 102.

19. The height of the mercury was 92, *viz.*. becauſe I tranſmitted part of the air into another receiver.

20. The aſcenſion of the mercury was 15.

22. Some air got out, and the height of the mercury was 63 ½.

23. The aſcenſion of it was 12 ½.

24. The aſcenſion of the mercury was four, the height of it was 79 digits; but the air being tranſmitted into another receiver, the height ſtaid at 62.

25.
26.
27.
28.

The aſcenſion was
8
9
4
5

30. The aſcenſion of it was 10, the height was 98. Part of the air being tranſmitted into another receiver, the height ſtaid at 64.

31. The aſcenſion was 6.

Aug. 1. The aſcenſion of the mercury was nine digits.

2. The aſcenſion of it was 4.

Aug. 3. I tranſmitted the air into another receiver, and the mercury ſtood in the height 68.

4. I tranſmitted the air again into another receiver, and the mercury reſted in the height 64.

6. The aſcenſion of the mercury was 7.

7. The aſcenſion of it was 4.

8. There was no aſcenſion thereof.

9. The aſcenſion thereof was three digits.

THE receiver being opened, I found the cherries of a whitiſh colour, and of very little taſte; but the taſte they had was not ungrateful; their fleſh or pulp was ſpungy.

FROM this experiment it ſeems to follow, that cherries contain much air in them, and that they produce it very irregularly,

EXPERIMENT II.

July 13, 1677. I PUT cherries into an empty receiver, and then I tranſmitted into the ſame receiver as much air produced from other cherries, as was ſufficient to ſuſtain 50 digits of mercury.

July 15. YESTERDAY the mercury had not aſcended at all; but this day it was two digits higher, *viz.* in 22 above its wonted height.

July 16. The height of the mercury was 23 ½.

17. The height of it was 25.

26. The height of it was 43. Some air got out.

27. The height of the mercury was 45. Some more air made an eſcape.

30. The height of it was 52.

31. The height of it was 61 digits.

Aug. 1. THE height of the mercury perſiſts in a manner the ſame, but the air brake out.

Aug. 27. THE air had all broke out for ſome time before: I took out the cherries, and found them not to have loſt their colour, as they had in the former experiment; and beſides they had contracted no putrefaction nor mouldineſs, but had a taſte a little more acid than they were wont to have; and being opened, there were many cavities in their pulp, like fermented paſte or dough, but not quite ſo thick.

FROM this experiment compared with the former it may probably be inferred, that in artificial air fruits do produce leſs air, and ſo they keep their colour and their taſte better; for the cherries, in the former experiment, remained included in a receiver, not much longer than thoſe in this.

EXPERIMENT III.

Common air.

Sept. 10, 1677. I PUT ſix ounces of unripe grapes into a receiver capable of containing 25 ounces of water; and I ſtopped it firmly, by the help of a ſcrew, with common air.

Sept. 11. The mercury aſcended not at all.
12. The mercury ſtopped a little below one digit.

13.	The height of it was	3½
14.		7
15.		10
16.		12½
17.		14
18.		16
19.		18
20.		20
21.		22
22.		23½

23. The height of it was 27. The grapes were not altered.
24. The height was 30.
25. The height was 31. The grapes now began to be yellow.

26.	The height of it was	32½
27.		34
29.		35
30.		35

Octob. 1. The height remained at 35.
2. The height was 36.
5. 6. The height ſtayed at 36.
10. The height was 35.
13. The height of it was 32½. The air got not forth, but the cold began to come on and encreaſe.
Nov. 9. The ſame height remained.

Dec. 19. I FOUND the air almoſt all to have made an eſcape.

Dec. 20. I TOOK out the grapes, and I found, that, by their ſmell and their taſte, they had contracted ſome mouldineſs, though the ſame was not diſcernable by the eye. Their firmneſs was encreaſed.

Factitious air.

Sept. 10, 1677. I INCLUDED two ounces of crude grapes in a receiver capable of holding eight ounces of water; and to the common air I ſuperadded air produced out of pears, until the mercury did ſtay 10 digits above its wonted preſſure.

Sept. 11. The mercury deſcended; its height was eight digits.

Sept. 12. The height of it was 11; the aſcenſion of it was 3.

Sept. 13.	The height of it was	16
14.		20
15.		23
16.		24

17. The height was 28; the grapes turned yellow.

18.	The height of it was	29
19.		30
20.		31
21.		33
22.		35
23.		20

Becauſe ſome air had broke out: the grapes were alſo of a yellow colour.
Sept. 24. The height of the mercury was 21 digits.
25. The height was 22.
26. The height almoſt the ſame.
Sept. 27. The height abode in 22.
29. The height was 27.
30. The height was 28.
Octob. 1 & 2. The height ſtayed at 28.

5.	The height of it was	30
6.		31
10.		31½
13.		31

Nov. 9. The height was 13. Some air had got out.
Dec. 19. The height of the mercury was 26 digits.

Dec. 20. I TOOK out the grapes, and their ſmell and taſte were more grateful than of others, and their firmneſs was rather increaſed than diminiſhed.

BY this experiment, made in two receivers at once, we learn; that factitious air ſeems fit to alter colour, and to preſerve taſte; but the firmneſs might be increaſed here, as it is augmented in turpentine; *viz.* the ſpirits, in tract of time, being exhaled.

EXPERIMENT IV.

July 18. I TOOK two pieces of orange; and by the help of my ſcrew I ſtopped them in faſt in my receiver with common air, and then into the ſame receiver I put air, produced out of cherries, as much as was ſufficient to ſuſtain 12 digits of mercury. At the ſame time I put another piece of the ſame orange into another receiver, with common air alone, and that not compreſſed.

July 20. THE orange, in common air, began to contract mouldineſs; the other ſeemed not at all to be altered.

July 23. THE mouldineſs of the orange in the common air increaſed; the other remained ſound.

July 16. THE orange, in the common air, did not proceed to increaſe its mouldineſs, but ſeemed wholly rotten; the other alſo began to putrify, but remained free from mouldineſs.

Aug. 1. PERCEIVING, that the oranges were no more ſenſibly changed, I opened the receivers; and though the air, wherewith I had mingled artificial air, was ſo compreſſed in its receiver, that now it could not ſuſtain 26 digits of mercury above its wonted preſſure, yet the fruits were far better preſerved in it than in the other; only ſomething in the ſuperficies ſeemed to have loſt its juice, but all the inner parts, with the rind or pill, were very well coloured, well taſted, and firm: in the other receiver, the whole orange ſeemed almoſt rotten, not excepting the rind. In the *Exper.* X. of *Artic.* IV. the orange was more corrupted in the compreſſed air, becauſe, as it ſeems, no factitious air had been mixed with it.

HERE alſo it ſeems worthy our obſervation, that the ſame air, generated from cherries, is apt to produce different effects upon fruits of a different kind; for here it retarded the alteration of colour and firmneſs, which in *Exper.* VII. of *Artic.* II. where I included air with apricocks, it accelerated and haſtened.

EXPE-

EXPERIMENT V.

Factitious air.

July 20, 1676. I INCLUDED a ſmall piece of beef in an exhauſted receiver, and then I put air, produced from cherries, into the ſame receiver, as much as ſufficed to ſuſtain 27 digits of mercury.

July 21.
22.
23.
25. } The mercury perſiſted almoſt in the ſame height, and came not to its wonted preſſure.

July 26. THIS day the beef had removed the receiver from its cover; and becauſe it ſtunk very much, we threw it away.

Common air.

July 20, 1676. I PUT a piece of beef into a receiver full of common air, and I carefully ſtopped and firmed it in, by the help of the ſcrew.

July 21. The mercury had not at all aſcended in the gage.

22. The height of the mercury was one digit.

23. The height of it was 5 $\frac{1}{2}$.

25. The height of it was 9 $\frac{1}{2}$.

26. The height of it was 14 $\frac{1}{4}$. In the evening 18.

27. The height of it was 21 $\frac{1}{2}$. In the evening 25.

28. The ſcrew, not being firm enough, ſuffered the air to break forth.

BY this experiment, made in two receivers at once, it appears, that air, produced from cherries, is a great hindrance to the production of air from fleſh.

EXPERIMENT VI.

Common air.

March 14, 1676. I PUT two onions into a receiver, full of common air, with a mercurial gage; and I faſtened the ſtopple with a ſcrew, to ſee whether vegetation would increaſe the quantity of the air, or diminiſh it.

March 28. TWO days after, the mercury ſeemed depreſſed $\frac{1}{2}$ of a digit; but afterward it recovered its former height, and two digits more; and now the air brake forth, and the roots grew longer.

April 28. ABOUT 10 or 12 days ſince I perceived the roots to be corrupted; and indeed now they were wholly putrified.

May 9. THE mercury perſiſted in the ſame height, becauſe the air had broke forth; and therefore I took out the onions, and found their roots putrified, but they were not mouldy at all.

Factitious air.

March 17, 1676. I INCLUDED two onions in an empty receiver, and afterward put air, produced from paſte, into the ſame receiver.

[illegible] root, at leaſt as well as thoſe, which I kept in the common air.

April 28. THE ends of the roots began to putrify; yet they were in far better caſe than thoſe, who are ſurrounded with common air. Perhaps the cauſe of this difference is to be fetched from hence, that a greater quantity of water was included with artificial air. The mercury mounted higher 9 or 10 digits.

May 18. HITHERTO the onions ſeemed not all to be corrupted, but this day I found one of them to have contracted ſome corruption, which may be called a ſyderation or planet-ſtriking, and differs from a mouldineſs.

FROM this experiment, made in two receivers at once, we may gather, that artificial air doth not at all hinder vegetation: it appears alſo thereby, that not only the ſenſible bigneſs of the body, but alſo the quantity of the air, is increaſed by vegetation.

EXPERIMENT VII.

Common Air.

Auguſt 25. I INCLUDED ſix ounces of unripe grapes in a receiver capable of holding 25 ounces of water, but I did not exhauſt the air.

Auguſt 26. The mercury aſcended a little.

27. The height of the mercury was one digit.

28. The height of it was 1 $\frac{1}{2}$.

29. The height of it was 1 $\frac{1}{4}$.

Auguſt 30. THE mercury ſeemed to have deſcended rather than aſcended. The colour of the grapes was leſs altered here, than in the receiver, into which air produced out of pears had been immitted.

Auguſt 31. THE receiver was broken, and I left the grapes expoſed to the free air.

Sept. 7. THE grapes being left in the free air, did ſtill keep their green colour, and were of a taſte grateful enough, though leſs pungent than before.

Factitious air.

Auguſt 25. I INCLUDED two ounces of unripe grapes in a receiver capable of holding eight ounces and $\frac{1}{4}$ of water; and having ſtopped it cloſe with a ſcrew, I filled it further with air, which I immitted, produced from pears, as much as ſufficed to ſuſtain 15 digits of mercury.

Auguſt 26. SOME air eſcaped out, and therefore I immitted new air, produced out of the ſame pears, until the mercury ſtaid at 17 digits above its wonted preſſure.

Auguſt 27. THE mercury was depreſſed below the 16 digit; and yet no air had brake forth. Towards evening, I found the mercury had again aſcended to 17.

Aug. 28. } The height of it was { 19
29. } { 21
30. } { 22
31. } { 23 $\frac{1}{2}$

Sept.

$$\left.\begin{array}{r}\textit{Sept.}\ 1.\\ 2.\end{array}\right\}\text{The height of it was}\left\{\begin{array}{l}24\\ 24\end{array}\right.$$

Sept. 4. THE ſame height continued at 24, and the grapes had all contracted a yellow colour.

Sept. 5. THE air broke out.

Sept. 7. THE air proceeding to get out by degrees, I took out the grapes, and found them very inſipid, and of an unacceptable taſte.

THIS experiment, made in two receivers at once, doth confirm to us the efficacy of artificial air, to alter the colour of fruits. It is alſo very obſervable, that in this experiment it did prejudice the preſervation of the taſte, and promoted the production of the air, contrary to what had happened in the former experiments. It would be worth the while to try, whether the ſame ſucceſs would evene with all unripe fruits.

EXPERIMENT VIII.

Factitious air.

Auguſt 2, 1676. I SHUT up one gilliflower in a receiver, with air produced from paſte made with meal, and not mixed.

Auguſt 4. OUR flower began to change colour and to be moiſt.

Auguſt 9. THE gilliflower was little altered.

Auguſt 12. THE moiſture increaſed by little and little, but no mouldineſs appeared.

Auguſt 31. THE gilliflower was little altered, yet it was leſs freſh than thoſe, which were kept *in vacuo*.

Common air.

Auguſt 2. I SHUT up one gilliflower in a receiver, with common air, not mixed.

Auguſt 4. OUR flower was not changed.

Auguſt 9. THE gilliflower was madid, and had almoſt loſt all its colour.

Auguſt 12. NOW a great mouldineſs covered all the flower.

Vacuum.

Auguſt 2. I INCLUDED two gilliflowers *in vacuo*; and took ſpecial care, that no humidity ſhould be included with them.

Auguſt 4, 1676. ONE of the gilliflowers began to appear madid.

Auguſt 31, 1677. DURING the whole elapſed year, the gilliflowers had ſuffered no mutation.

BY this experiment, inſtituted in three receivers at once, it ſeems probable, that factitious air doth render the change of colour more ſpeedy, yet it prevents mouldineſs, even as *vacuum* doth the ſame.

EXPERIMENT IX.

Common air.

July 24. I PUT apricocks, and ſome plums, of which divers were cut in pieces, into a receiver full of common air, and ſtopped it firmly with a ſcrew.

July 25. THE mercurial gage was ſpoiled, and therefore I could not by any means perceive the quantity of the air to be generated.

July 30. THE fruits ſeemed not at all to be altered, ſaving, that one of the diſſected plums had contracted ſomething of mouldineſs.

Auguſt 2. I OPENED the receiver, and found all the fruits firm, of a good colour, and of a grateful taſte.

Artificial air.

July 24. I MADE the ſame experiment in another receiver, with the ſame circumſtances, ſave only, that into this laſt receiver I intruded air, produced from cherries, as much as was ſufficient to ſuſtain 22 digits of mercury.

July 25. I FOUND the mercury to have deſcended three digits; it ſtaid in 19. Toward the evening it recovered its former height; it ſtaid in 22.

$$\left.\begin{array}{r}\textit{July}\ 26.\\ 27.\\ 28.\\ 29.\end{array}\right\}\text{The height of it was}\left\{\begin{array}{l}28\\ 34\tfrac{1}{2}\\ 36\\ 40\end{array}\right.$$

July 30. The height was 44. The apricocks, which were cut, began to moiſten, and to be diſſolved into water.

31. The height was 51.

Agu. 1. The height was 60.

2. The height was 65. Towards evening, when I found ſome liquor had eſcaped out of the receiver, I ſcrewed it more ſtraitly; but one of the iron wires being broken, all the air got out. Wherefore I took out the fruits, and found them very ſoft, eſpecially thoſe whoſe lower parts were immerged in the water; for the reſt they were a little more firm, but all of them retained a grateful taſte.

FROM this experiment made in two receivers, it ſeems to be inferrible, that air produced from cherries doth promote the alteration both of colour, and alſo of firmneſs in apricocks.

IT appears alſo, that ſome part of ſuch air is deſtroyed in the beginning.

EXPERIMENT X.

July 30, 1676. I PUT plums, cut aſunder, into three receivers, of which one was full of artificial air, produced from gooſberries; the ſecond was full of common air; the third was vacuous.

Auguſt 2. IN the artificial air, the plums were not changed; in the common air, they began to be mouldy; but in the evacuated receiver, they retained their colour, but were ſoft.

Auguſt 5. IN the artificial air the plums had contracted a red colour, humidity, and ſoftneſs; in the common air they ſeemed black and mouldy, yet retaining their firmneſs; in the evacuated receiver they were almoſt melted or diſſolved.

Auguſt 7. In the common air the plums now began to ſoften.

Auguſt 8. In the common air, the plums ſeemed to have loſt their black colour, and to have contracted a red one; even as it happened three days ago to the plums in the artificial air.

In this experiment, artificial air ſeems to have promoted alteration.

EXPERIMENT XI.

Sept. 24. I put five peaches into a receiver, with common air mixed with air produced from grapes; and I included the grapes themſelves in the ſame receiver, that the common air might be the better ſaturated with the artificial.

Sept. 25. The height of the mercury was 21 digits.

Sept. 26.	The height of it was	23
27.		31
28.		39
29.		42
30.		45
Octob. 1.		48

2. The ſame height continued.

3. The height of it was 52½.

5. The height the ſame; but the peaches ſeemed ſomewhat madid.

6. The height of it was 58.

7. The height of it was the ſame.

8. The height of it was 61.

11. The mercury aſcended a little.

19. The height of it was 65.

25. The height of it was 61. The cold was ſharp.

27. The cold abated, and the mercury aſcended.

30. The height ſtaid at 61, and a little more.

Nov. 2. The height of the mercury was 59. It was bitter cold weather.

6. The height of it was 61. The froſt broke and was diſſolved.

7. The mercury ſeemed ſomewhat higher.

9. The mercury perſiſted in the ſame height.

Decem. 9. In one month's ſpace the mercury aſcended by little and little; its height was 80 digits.

April 1, 1678. The mercury came to 96 digits above its wonted height. And I opened the receiver, and whilſt the air was breaking out, the peaches did emit many bubbles through their ſkin, not without violent noiſe, and the ſkin in ſome of them was broken: they had preſerved their taſte pleaſant enough, and the colour of their pulp was commendable, but they had loſt their firmneſs, as if they had been boiled: being left in the air for three hours ſpace, they were all rotten.

This experiment proves, that common air doth corrupt bodies, yet it doth ſo much leſs, if it be mixed with factitious air.

EXPERIMENT XII.

The firſt receiver.

Auguſt 4. I cut five pears, each of them into four parts, and I put one part of each into a receiver full of common air, and ſtopped it cloſe with a ſcrew.

Auguſt 6. The colour of theſe fruits was altered little leſs than of others; the mercury aſcended not at all.

Auguſt 7. The pears were little altered; the mercury was higher by a little.

Auguſt 8. The pears underwent no great mutation. The height of the mercury was four digits.

Aug. 9.	The height of it was	4½
10.		6
11.		10
13.		16
14.		20

The pears began to be ſoftned.

15. The height of it was 21.

16. The height of it was 19. I believe the air had got out.

17. Now I found the air had eſcaped out.

18. When the air had almoſt all got out ſince yeſterday in the evening, and I ſaw the fruits to look worſe than before, I took them out, and found them putrified.

The ſecond receiver.

Aug. 4. I took one quarter of each of the aforeſaid pears, and included it after the ſame manner; and afterwards I immitted air, produced out of cherries, till the mercury poſſeſſed 23 digits above its wonted preſſure.

Auguſt 6. Those fruits had altered nothing, but their colour a little.

Auguſt 7. The pears, almoſt all, ſeemed rotten. The mercury perſiſted in the ſame height.

Auguſt 8. The pears were not altered much more. Something hindered, that I could not ſee the mercury.

Auguſt 10. The pears waxed more and more ſoft. Now looking upon the height of the mercury, it was 40 digits more than its wonted height.

Auguſt 11.	The height of it was	51
13.		61
14.		67
15.		73

16. The mercury deſcended; yet I know aſſuredly, that nothing had got out.

17. The mercury exceeded not 69 digits in height, yet the air could by no means eſcape out.

18. The mercury perſiſted at the ſame height, but I ſuffered the

air to break forth; it affected my noſtrils with a ſharp odour: moreover, the taſte of the fruits ſeemed very acid, and their pulp exceeding ſoft.

The third receiver.

Auguſt 4, 1677. I put a quarter of each of the foreſaid pears into a receiver, not exactly ſhut.

Auguſt 6. The pears ſeemed to change their colour.

Auguſt 7. One of our pieces of pears began to loſe its firmneſs: but in the artificial air, another piece of the ſame pear did yeſterday ſeem wholly rotten.

Auguſt 8. One piece was mouldy, the reſt were ſoft.

Auguſt 9. The pears grew more and more rotten.

Auguſt 11. The pears were wholly mucid and rotten.

This receiver, compared with the firſt, ſhews, that corruption doth not begin in free air ſooner than in included air; but when it is begun, it is much more, yea, and more ſpeedily increaſed, *viz.* becauſe the included air might be ſatiated.

The fourth receiver.

Auguſt 4, 1677. I included one quarter of each of the ſaid pears *in vacuo*.

Auguſt 6. The height of the mercury was 5.

	The height of it was
Auguſt 7.	8
8.	10
9.	12
10.	14
11.	16
13.	20
14.	23
15.	25
17.	28

Auguſt 20. Hitherto the pears had undergone no alteration, but this day they began to be ſoft: the mercury aſcended not.

Auguſt 26. Neither the pears, nor the height of the mercury were altered at all.

This production of the air ſeems very regular.

By this experiment, made in 4 receivers at once, we find the aptitude of artificial air for the ſoftning of fruits.

And that the production of air was here promoted by artificial air, is very probable; yet it had ſucceeded otherwiſe with apricocks, *Art.* II. *Exper.* VII.

EXPERIMENT XIII.

The firſt receiver.

Auguſt 21, 1677. I divided ſix apricocks, each into four parts, and I put one piece of each into a receiver full of common air, and ſtopped it firmly with a ſcrew.

Auguſt 22. The apricocks ſeemed riper this day than yeſterday; but no air was produced by them.

Auguſt 23. One piece, contiguous to the water, began to be mouldy; the reſt inclined to putrefaction: the mercury ſeemed to have aſcended a little.

Auguſt 24. A piece next the water, was covered with a great deal of mouldineſs; another piece, more remote from the water, was ſomewhat mouldy alſo; but all were rotten.

Auguſt 25. The fruits contracted no more mouldineſs; but the putrefaction more and more increaſed. The height of the mercury was ſeven digits.

Auguſt 26. The height of the mercury was 15 digits.
28. The height of it was 30.
29. The ſame height continued.
30. The height of it was 33. The fruits were almoſt all diſſolved.
31. The height of it was 38.
Septem. 1. The height of the mercury was the ſame.
2. The ſame height ſtill.
3. The mercury aſcended a little.

	The height of it was
4.	41
5.	43
7.	45
8.	46

9. The ſame height continued.
22. Little or no change was made in the height of the mercury; but the fruits were almoſt melted into water.

Octob. 1. When the mercury continued in the ſame height, and the fruits were almoſt all vaniſhed, I opened the receiver, and found the apricocks very much impaired, and ſoft; yet they had retained a taſte, not ungrateful, but ſubacid.

The ſecond receiver.

Auguſt 21, 1677. I covered one quarter of each of the foreſaid fruits, the receiver not being fortified againſt external air.

Auguſt 22. The apricocks were flaccid or quailed, as if they had been dry or withered.

Aug. 23. Many of our fruits appeared rotten and mouldy.

Aug. 24. The apricocks were wholly infected with putrefaction and mouldineſs.

The THIRD RECEIVER.

Aug. 21. I included firmly, by the help of a ſcrew, one quarter of each of the foreſaid fruits, in an unexhauſted receiver; to which I after added air produced from pears, as much as ſufficed to ſuſtain 20 digits of mercury.

Aug. 22. The mercury aſcended not at all; but the fruits ſeemed to have acquired a greater degree of maturity than thoſe, which are included in common air.

Aug. 23. These fruits ſeemed leſs altered than they, which were in common air.

Aug. 24. THE fruits were not altered.

25. THE fruits did begin to produce air, but I could not diſcern the quantity.

Aug. 26. LITTLE alteration in the fruits.

28. THE apricocks began to be finewed, yet they were far leſs altered than thoſe which remain in common air.

Aug. 30. THE mercury did this day emerge above the bodies by which it was hid. Its height above the wonted preſſure was 30 digits.

Aug. 31. The height of the mercury was 40 digits.
Sept. 1. The height of it was the ſame.
2. The ſame height continues.
3. The height thereof 45.
8. The height was little changed.
9. The height was 40, and yet no air got out.
Sept. 11. The height was 38.
12. The mercury continued to deſcend.
Sept. 13. The height of it was 33.
Sept. 14. The mercury was ſo depreſſed, that it appeared no more.
Sept. 22. The mercury did emerge again; its height was 33. The fruits were covered with a kind of mucor or finew.

Octob. 1. WHEN the height of the mercury, nor the apricocks, were any more altered, and the finew vaniſhed away, I opened the receiver, and found the apricocks not impaired, but of a colour laudable enough; but their pulp was ſpungy and ſoft, and of a ſubacid taſte.

The Fourth Receiver.

Aug. 21. I TOOK a quarter of each of the aforeſaid fruits, and ſhut them up firmly with a ſcrew in an unexhauſted receiver, into which afterwards I intruded air, till the mercury came to 90 digits above its accuſtomed preſſure.

Aug. 22. OUR receiver broke into an hundred pieces, by the force of the air compreſſed within it: whereupon I put the fruits into another receiver, and added only ſuch a quantity of air, as was able to ſuſtain 60 digits of mercury.

Aug. 25. THE apricocks had contracted much mouldineſs; I added new air.

Aug. 26. THE apricocks were wholly infected with mouldineſs, and rottenneſs.

THIS receiver, if compared with the former, doth ſhew, that the quantity of corruption doth depend on the quantity of the air.

BY this experiment made in four receivers at once, we have a confirmation, that in factitious air, alteration is made quicker; but in tract of time, the corruption is far greater in common air.

ARTICLE IV.

The effects of compreſſed air are different from the effects of common air.

EXPERIMENT I.

March 21, 1677. I PUT two onions into a receiver, which was to be ſtopped cloſe with a ſcrew, and I intruded ſo much common air thereinto, that raiſed the mercury 60 digits above its wonted preſſure.

March 28. MY onions took root, as well as other onions, which I had included in common air at the ſame time.

April 28. THE onions included in common air eight days ago were covered with mouldineſs, though in the beginning they had put forth roots numerous enough: the onions in the other receiver began to contract corruption at the ends of their roots; but the compreſſed air 10 days before had found a gradual paſſage out, and now was almoſt all eſcaped: and therefore I put in new air, till the mercury had attained to the height of 60 digits above its accuſtomed preſſure.

April 29. THE onions in the compreſſed air were all over covered with mouldineſs.

FROM this experiment it ſeems to follow, that a little compreſſion doth not prejudice thoſe bodies, which are to be expanded by vegetation.

MOREOVER, the new air, which was intruded, ſeems to have promoted the mouldineſs; though, in the beginning, it is probable, that the compreſſion of the air did retard both the mouldineſs, and alſo the corruption.

EXPERIMENT II.

May 9. I PUT two equal quantities of tulips and lark-ſpurs into two receivers of an equal bigneſs, and ſtopped them up firmly with ſcrews: I left one of them with common air only; but I compreſſed the other with the intruſion of new air, till the mercury did exceed its wonted height by 70 digits.

May 11. Two tulips, in the common air, contracted mouldineſs; but all things remained unaltered in the compreſſed air.

May 12. A THIRD tulip, in the common air, began to be finewed; but there was no ſuch thing in the compreſſed air.

May 14. THIS day I perceived one tulip in the compreſſed air to be infected with ſome mucor or finew; but thoſe, which remained in the common air, were all very mucid; and alſo one of the lark-ſpurs, in the common air, had contracted a mucor.

May 17. THREE of the tulips, in the compreſſed air, had indeed contracted a finew, but not half ſo much as tulips in the common air were covered with. And moreover, two of the lark-ſpurs in the common air appeared finewed alſo; but thoſe ſhut up in compreſſed air, were preſerved freſh, and wholly free from mouldineſs or finew.

May 21. THE flowers in the common air were all rotten and putrified; but the other in the compreſſed air, received no further alteration: and beſides, the tulips, which had contracted ſome finew, ſeemed rather to loſe that, than to acquire new.

May 30. WHEN the flowers, in the common air, being wholly putrid, were diſſolved into water, I took them out, and kept the liquor in the veſſel, to try whether any inſects would breed therein. In the compreſſed air the flowers ſuffered no more ſenſible alteration; and therefore I took them out, and found them madid, and infected with a ſubacid odour.

BY this experiment it ſeems plain, that compreſſed air doth hinder putrefaction and mouldineſs in ſome plants.

EXPERIMENT III.

May 21, 1677. I CUT an orange into equal parts, and one of the halfs I ſtopped up in a receiver, with air ſo compreſſed, that it would ſuſtain 100 digits of mercury above its wonted preſſure; but I left the other half in another receiver, well ſhut, only with common air.

May 25. EACH half of the orange had contracted mouldineſs, but that which was in the common air, was much more mucid than the other.

May 26. THIS day I perceived that the compreſſed air had almoſt all got out, and therefore I put in new.

May 30. EVERY day I perceived ſome air had got forth, and therefore I made a daily ſupply by adding new. And it came to paſs that the orange, by receiving new air, ſo often admitted, had contracted a mucor, notwithſtanding the compreſſion, much more than the other piece of orange, that was always left in the ſame air without preſſure.

June 1. I TOOK out the two half oranges, and that which remained in the compreſſed air, ſeemed to have contracted a corruption, at leaſt, three times greater than that, which had continued in the common air.

BY this experiment, the aptitude of compreſſed air, to retard corruption, is confirmed; yet, in progreſs of time, it is very probable, that the quantity of corruption doth depend upon the quantity of the air. See *Exper*. 1.

EXPERIMENT IV.

May 31, 1677. I INCLUDED two equal quantities of roſes in two receivers, which I ſtopped by the help of ſcrews, into one of which I intruded as much air as would ſuffice to ſuſtain 90 digits of mercury, beſides its accuſtomed preſſure; but I left the other only with common air.

June 11. THE roſes, in the common air, were free from mouldineſs, only they ſeemed to have loſt ſomething of their colour; but thoſe, which were ſhut up in the compreſſed air, had almoſt all contracted a yellow colour, as if they had withered in the open air, and yet they were not mucid or finewed.

June 18. THIS laſt week the flowers in the common air admitted not the leaſt change; but thoſe in the compreſſed air grew more and more yellow. I opened both receivers, and found the roſes to have kept their ſmell, yet it was ſomewhat altered; neither of them were dry nor withered. I kept them apart in the open air, and found, that the roſes, taken out from the compreſſed air, were not ſo ſoon altered by the contact of new air, as thoſe which had remained in the air not compreſſed.

FROM this experiment it ſeems to follow, that compreſſed air is ſometimes fitter for the alteration of colour than common air. And perhaps it may not be unworthy of our notice, that roſes ſo included contract not a mouldineſs, but only a yellow colour; but in tulips and larkſpurs, the matter ſucceeded otherwiſe. See *exper*. 2.

EXPERIMENT V.

June 1, 1677. I PUT the two halfs of the ſame orange in two receivers: in the one I increaſed the quantity of air till it ſuſtained the mercury 100 digits above its wonted height; but I left the other uncompreſſed, only exactly ſhut.

June 6. EACH half of the orange was infected with mouldineſs, eſpecially that, whoſe ambient air was compreſſed. But note, that new air was every day to be ſupplied thereunto; for the compreſſed air in 24 hours ſpace had almoſt all got out: but in *exper*. 3. it had remained very well ſhut in for ſix whole days.

June 11. THE orange in the common air contracted no more mouldineſs; but in the compreſſed air, the mucor or mouldineſs was more and more increaſed.

June 18. FINDING the mouldineſs of the orange in the common air to be leſſened, rather than increaſed, I took it out; and perceiving further, that in compreſſed air the orange was not more mucid, after I had ceaſed to intrude new air, I was willing to try, whether the new air did ſuppeditate new ſtrength to the orange, to exert and thruſt out its mouldineſs; therefore I made the mercury in the gage, by reaſon of the air I intruded, to exceed its wonted height 80 digits.

June 20. Two days after I had intruded new air into the receiver, the mouldineſs of the orange appeared to be manifeſtly augmented.

FROM this experiment we may gather, that the quantity of the mouldineſs doth depend on the quantity of the air.

EXPERIMENT VI.

June 17, 1677. I PUT two ſhrew-mice into two receivers, of equal bigneſs, and ſtopped them up carefully: in one of them I left only common air; into the other I intruded air, till the mercury was higher than its wonted preſſure 30 digits: but the mouſe in the common air was included about 5 and 52', 6 after the other.

THE mouſe in the compreſſed air ſeemed to loſe his ſtrength much ſooner than the other, the motion of his breaſt being leſs frequent. Yet notwithſtanding about 6 and 18', the mouſe in the common air, which ſeemed the ſtronger, fell into convulſive fits and died; but the mouſe in the compreſſed air ſeemed then, and ſome time after, to be as well as it was an hour and half before.

ABOUT eleven of the clock, the mouſe in the compreſſed air did as yet breathe, but about four in the morning he was found dead in the ſame poſture, wherein he was ſeven hours before: whence we may conjecture, that he was free from convulſive fits.

I MUST not here omit to relate, that the mouſe in the common air had conſumed ſomething of that air, ſo that the mercury ſtood at 29 digits, which, when the receiver opened, preſently aſcended to 30.

FROM this experiment we learn, that compreſſed air ſeems fitter than common air for the prolongation of life, ſeeing the one mouſe lived 24' and no more, but the other lived about 15 turns longer, though only a double quantity of air was included in his receiver.

EXPERIMENT VII.

June 13, 1677. I PUT four flies into a receiver, into which I afterwards intruded air, till the mercury did occupy 60 digits above its wonted height; and at the ſame time I included three other flies in another receiver, with common air not compreſſed.

June 14. THIS day in the morning all the flies were well. In the afternoon I found two of them dead in the compreſſed air, but in the common air they were all alive. About five of the clock one of the flies in the compreſſed air was alive, and three in the common air.

June 15. THIS morning I found all the flies in the common air dead; but that ſingle one, which remained alive in the compreſſed air, ſeemed ſtill to be very well, and being taken out of the receiver, flew ſpeedily away.

FROM this experiment it ſeems to follow, that flies are not very ſenſible of the compreſſion of the air; and that they die more for hunger than for default of air: for the flie, which was ſo long well, fed upon the carcaſſes of thoſe which were dead, ſo that ſhe ſeemed to be affected with no diſtemper. Yet I iterated the experiment. See *exper*. 8.

EXPERIMENT VIII.

June 15. I REPEATED the former experiment, only including four flies in each receiver, and compreſſing the air ſomewhat more.

June 16. THIS morning I found two of the flies in the common air dead, and but one in the compreſſed air.

ABOUT two in the afternoon the four flies in the common air ſeemed to be dead; but in the compreſſed air, the three were alive.

June 17. ALL the flies died, except one in the compreſſed air.

FROM this, and the former experiment, a man may conjecture, that the compreſſion of the air is of ſmall conſequence to flies; and indeed they are not prejudiced by the rarefaction of the air, but with great difficulty, unleſs there be almoſt a complete *vacuum*.

EXPERIMENT IX.

June 18. I INCLUDED two frogs in two receivers, and ſtopped them by the help of ſcrews; the one only with common air, the other with air compreſſed to ſuſtain 70 digits of mercury.

June 19. BOTH the frogs were alive; and the height of the mercury in both receivers remained the ſame.

June 20. NEITHER of the frogs were dead, and they ſeemed to me rather to diminiſh than increaſe the air, but the difference was ſo ſmall, that I dare not be poſitive therein.

June 21. IN the morning both the frogs were alive; but towards evening the frog in the common air was found dead.

June 22. AT evening the frog in the compreſſed air was alive.

June 23. IN the morning I found the frog dead.

IT muſt be found out by iterated experiments, whether the greater length of life was to be aſcribed to the compreſſion of the air, or to the diſpoſition of the frogs.

EXPERIMENT X.

June 18, 1677. I SHUT two half parts of the ſame orange in two receivers, and ſtopped them by the help of ſcrews; the one with common air, the other with air compreſſed to ſuſtain 90 digits of mercury.

June 22. THIS morning I found the orange in the common air to be infected with mouldineſs, but the other was ſound.

AT three of the clock in the afternoon, the orange in the compreſſed aid ſeemed alſo to have contracted ſome mucor.

June 23. I FOUND the orange in the common air far more mucid than the other.

June 24. THE orange in the common air did not increaſe his mouldineſs, but the other was covered all over with it.

June 28. THE mouldineſs produced in the common air was now wholly vaniſhed; in the other receiver, I ſaw no further alteration in the fruit.

June 30. PERCEIVING that the fruits perſiſted in the ſame ſtate, I took them out. The half orange, which was kept in common air, ſeemed half rotten; but the other beſides its ſinew, appeared wholly putrified.

BY this experiment we have a confirmation, that the quantity of the mouldineſs or finew doth depend upon the quantity of the air.

IT ſeems alſo worthy of obſervation, that the mouldineſs, or hoarineſs, did appear a little later in the compreſſed air than in the common, though afterwards it increaſed much more.

EXPERIMENT XI.

June 29, 1677. I INCLUDED roſes in two receivers, ſtopped by the help of ſcrews; I left one with common air only, but I filled the other with ſo much air, intruded by force, that the mercury aſcended to 90 digits above its wonted preſſure.

July 14. FOUR or five days ago I found the roſes in the compreſſed air to wither and to degenerate into a yellow colour. There was not the leaſt alteration in the other receiver.

July 17. WHEN I perceived, that this preſent experiment proceeded after the ſame manner, as that mentioned p. 121. I took out the roſes. Thoſe kept in the compreſſed air, were very much corrupted, and of a very ungrateful ſmell; but the others we little altered; and their ſmell not unpleaſant.

HENCE we have a further confirmation, that the quantity of corruption doth depend on the quantity of the air.

EXPERIMENT XII.

July 4. I cut a lemon aſunder, and put both halfs into two receivers, to be ſtopped by the help of ſcrews: the one I left with common air only, but the other I filled with ſo much compreſſed air, that it ſuſtained 90 digits of mercury above its wonted preſſure.

July 7. This day both parts of the lemon ſeemed to grow mouldy at the ſame time.

July 17. The part of the lemon in the compreſſed air had contracted much more of hoar or finew, than the other: and perceiving no further alteration in them, I took them out, and found the lemon in the compreſſed air far more putrid than the other.

By this experiment it is confirmed, that the quantity of corruption doth depend on the quantity of the air.

It ſeems alſo, that a triple compreſſion of the air, in reſpect of a lemon, is too weak ſenſibly to retard the production of mouldineſs or finew.

EXPERIMENT XIII.

July 18, 1677. I INCLUDED two parcels of gilliflowers, equal in number, in two equal receivers, and ſtopped them cloſe with ſcrews. I filled the one with compreſſed air, till it ſuſtained 100 digits of mercury above the wonted preſſure; but the other was left with common air alone.

July 23. IN the compreſſed air, the gilliflowers were bedewed with ſome hoarineſs or mould; the others appeared only moiſt: but the mercury exceeded its wonted height only 70 digits, becauſe ſome of the air had got forth.

July 25. IN the compreſſed air, the gilliflowers proceeded to be much more corrupted than the others: they had wholly loſt their colour.

July 26. IN the compreſſed air, the gilliflowers were wholly putrified, and covered with an hoary finew: the others were moiſt only in ſome places.

Aug. 1. PERCEIVING no further alteration in the gilliflowers, I took them out of their receivers: thoſe which were kept in compreſſed air were rotten, and did ſtink; but the other kept their colour, and their ſmell was not offenſive, but they were moiſt.

THIS experiment confirms, that the quantity of the air doth increaſe corruption.

WE may alſo obſerve, that the mouldineſs or hoarineſs is not produced, but in compreſſed air; neither is it probable, that this happened by chance, ſeeing, in each receiver, there were four gilliflowers included, or three at leaſt.

EXPERIMENT XIV.

July 21, 1677. I INCLUDED a ſhrew-mouſe in a recipient, with common air, and ſhut it in firmly with a ſcrew, to try whether he would produce or conſume air.

AFTER two hours the mouſe died, and ſome air was conſumed, but a leſs quantity than in the experiment mentioned, p. 121.

July 24. HITHERTO I found no change in the height of the mercury.

TOWARDS evening it ſeemed a little higher.

July 25. THIS day in the morning much air was produced *de novo*.

July 26. THE quantity of the produced air increaſed more and more.

BY this experiment we have a confirmation, that living animals do conſume air, but dead ones produce new.

EXPERIMENT XV.

Compreſſed air.

Aug. 31. I PUT pears into a receiver, whereto, after it was well ſtopped, I added as much air, as ſufficed to ſuſtain 30 digits of mercury above the wonted preſſure.

Sept. 1. The mercury was depreſſed, as it happened fol 108.

Sept. 2. The height of the mercury decreaſed: it exceeded not 25 digits.

Sept. 3. This day the mercury proceeded one digit higher: it ſtayed in 26.

Sept. 4. The height thereof was 28.

Sept. 8. BECAUSE the receiver did afford ſome efflux to the air, I therefore put in new: and this day, opening the receiver, to compare the taſte of theſe fruits with the taſte of the others, I found, that five of the pears had loſt their firmneſs, but two had retained it.

Common air.

Aug. 31. I INCLUDED pears of the ſame kind in another receiver, with common air only, not compreſſed.

Sept. 1. THE mercury was a little depreſſed, as if it been in compreſſed air: the cauſe whereof I judge attributable only to the cold.

Sept. 2. The mercury was not changed.

Sept. 3. The height of the mercury was one digit above the wonted preſſure.

Sept. 4.	The height of it was	4
5.		$6\frac{3}{4}$
6.		$6\frac{1}{3}$
7.		12

Sept. 8. The height of the mercury was 20. The pears being taken out of the receiver, had preſerved their taſte much better than thoſe, which were included *in vacuo.* They alſo retained their firmneſs.

VACUUM.

Aug. 31. I INCLUDED pears of the ſame ſort *in vacuo*; but ſome external air brake in, and the height of the mercury was one digit.

Sept. 1	The height of it was	4
2		8
3		12
4		16
5		19
6		23
7		27
8		30

THE pears, being taken out, had kept their firmneſs, but had loſt much of their taſte.

FROM this experiment made in three receivers at once, it ſeems to follow, that in a greater compreſſion, a leſs quantity of air is produced.

EXPERIMENT XVI.

Dec. 7. I SHUT up a ſmall bird in a receiver, capable of holding twenty ounces of water. The bird began to be ill, before I had ſet the ſcrew; but after I had intruded ſo much air, as could ſuſtain 30 digits of mercury, above its wonted height, ſhe ſeemed to recover again; but in ſome ſpace of time after, ſhe began again to be ſick, and therefore I intruded air the ſecond time, till the mercury ſtaid in 45 digits above its wonted height, and then the bird was again reſtored to health, but a little time after ſhe began to gaſp again; then opening the receiver, after ſhe had ſtaid in it 28 minutes, ſhe got out, and was very well.

EXPERIMENT XVII.

Jan. 20, 1678. I PUT a ſhrew mouſe into the receiver of my wind-gun, whoſe elliptick aperture was ſcituate in its upper part, the figure of it is ſet down p. 104, 105. Then as quick as I could, I ſo far condenſed the air there, till it was reduced to the twentieth part of its ſpace, or thereabouts; and then I preſently diſcharged that air, and the elliptick hole being opened, I ſuſpected, that the mouſe had been only a little convulſive; but when he was taken out, there were no ſigns of life in him. And therefore it is left to enquiry, whether the cauſe of his death were to be aſcribed to the narrowneſs of the receiver, or to the compreſſion of the air?

WHEREFORE I put another mouſe into the ſame receiver, and the air being reduced to a third or fourth part of its ſpace, I opened the receiver, but not ſo carefully as I had done in the former experiment; yet the mouſe taken out therefrom, was found to be very well.

I AFTERWARD repeated the ſame experiment, the air being about ſeven or eight times condenſed, and the mouſe ſeemed to ſuffer no inconvenience thereby.

I TRIED the ſame experiment again in air, compreſſed ſeven times, and left the mouſe included for 24 minutes; which time being elapſed, I diſcharged the air, and the hole being opened, I perceived the mouſe to fetch many deep groans, as it were; yet, being taken out, he could not recover his health again.

BY theſe experiments it is manifeſt, that a great compreſſion of air is noxious, yea mortiferous to animals.

EXPERIMENT XVIII.

Jan. 28, 1678. I PUT a ſhrew mouſe into a glaſs, to whoſe neck I tied a bladder ſtopping the orifice. Theſe things being thus prepared, I put them into a receiver for the compreſſing of the air. A little time after, when the mouſe began to be ſick, I compreſſed the air, and the bladder was ſtraitned, and ſo the mouſe was found in compreſſed air, though no new air could penetrate to him: then he ſeemed to be much better, and his heart did not pant ſo often; and opening the receiver, in a ſhort time, he was as well as ever.

I ITERATED the ſame experiment, and the mouſe was left there ſo long, that he could hardly breathe, whilſt I began to compreſs the air; and the compreſſion ſeemed again to abate his reſpiration; the receiver being opened, and ſo the mouſe expoſed to the air could not breath much more freely; but if I blew the air on him by bellows, he ſeemed to be ſomething relieved; but being again committed to the compreſſed air, he breathed leſs frequently, and at laſt died.

March 25. BECAUSE in the former experiment it was not clearly manifeſt, whether the air did enter through the ligature of the bladder, I uſed the inſtrument deſcribed p. 104. And when I perceived, that the mouſe was ſick, and breathed ſeldom, I intruded water into the receiver, ſo that the air was reduced to half of its ſpace, and then the mouſe breathed more rarely; but if, extracting the water, I left the whole ſpace entire for the air, his reſpiration ſeemed more vivid; and the air being thus many times contracted and dilated, the ſick mouſe ſeemed to me to breathe more lively in the common air, than in the compreſſed. Whence I conjectured, that the air is to animals like food, the quantity whereof ought to bear ſome proportion with their ſtrength: and that I might more certainly know it, I put the ſame mouſe into my pneumatick engine, and rarefied the air, ſo that it poſſeſſed more than double the ſpace it was wont; whilſt the air was rarefying, preſently the mouſe began to be better; yet a little while after he ſeemed to be ſick, and when the air was reſtored, it brought no ſenſible commodity or inconvenience to the mouſe. I thus repeated the rarefaction three times, and the ſame ſucceſs followed; but at laſt the mouſe died.

ARTICLE V.

The effects of artificial air upon animals.

EXPERIMENT I.

May 5, 1677. I PUT a bee, with vinegar diſtilled, and pulverized coral, into an emptied recipient; and the air being wholly exhauſted, I ordered the matter ſo, that the coral fell down into the glaſs of vinegar: but the air, produced from thence, did not reſtore any power or motion to the bee; but when ſhe was expoſed to the open air, in a little time after ſhe began to move herſelf.

HENCE a ſuſpicion doth ariſe, that artificial air is unfit for the life of animals.

EXPERIMENT II.

Aug. 12, 1676. I PUT two flies into a receiver, and exhauſting the common air, I ſubſtituted air, produced from gooſberries, in its place, as much as could ſuſtain 26 digits of mercury.

AFTERWARDS I put two other flies alſo *in vacuo*; but with this difference, that I reſtored common air to theſe latter flies, only in that quantity, as could ſuſtain 23 digits of mercury.

WITHIN a quarter of an hour, theſe latter flies, upon the reſtitution of the air, recovered that power of motion, which they had loſt *in vacuo*, and did flie in the rarefied air; but the former lay without any motion, though they had received a greater quantity of air.

Aug. 13. THE flies in the artificial air, ſeemed ſtill dead; but the others were luſty.

The flies taken out of the artificial air, and expoſed to the common air, remained ſo all this whole day, and yet did not recover any life.

Aug. 18. I RENEWED the ſame experiment, with the ſame ſucceſs, though I had reſtored a greater quantity of artificial air.

HENCE we have an high confirmation, that artificial air is noxious to the life of animals.

EXPERIMENT III.

June 22, 1677. I PUT paſte into three receivers, out of which I afterwards exhauſted the air.

June 23. WHEN my three receivers did this day regurgitate with air produced from the paſte, I kindled a perfumed cone, and thus kindled I put it into one of my receivers, which being preſently ſtopped, the fire, within one minute of time, went out. Then by blowing, I expelled the artificial air from the receiver, and put in fire to it, as before; and then it burned bright for a pretty long time, though I had ſhut the receiver as ſpeedily, and as accurately as before.

I TRIED another experiment, after the ſame manner, with a fly, and in the artificial air ſhe was preſently dead, as it were; but afterward, being expoſed to the ſun, ſhe, in a ſhort time, grew well again. Then I blowed in common air into the receiver, which being done, the fly included as before, ſuffered no inconvenience thereby.

I ITERATED the ſelf-ſame experiment with the ſame fly in our third receiver, being filled with artificial air, and the ſame ſucceſs followed; ſave only that this fly, when it was taken out from the artificial air, could not be reſtored to health, but in a longer time, *viz.* becauſe ſhe was left there longer.

BY theſe experiments it appears, that factitious air is prejudicial to fire, as well as to the life of animals.

EXPERIMENT IV.

June 25, 1677. I PUT paſte into four receivers, and exhauſting the air wholly from two of them, I pumped out only half the air from the other two.

June 26. I FOUND the two receivers, which I had left half full with common air, to be quite filled with air newly produced; neither dare I aſſert, whether they had, for ſome time, regurgitated or no, ſo that the qnantity of common air was much diminiſhed. However the matter was, I put two flies at once into one of the receivers, after the manner before deſcribed; and they, as ſoon as they touched the bottom of the receiver, in a very little while after remained without motion. I put a third fly into the receiver, after the ſame manner, and found ſhe lived a little longer there than the former. A fourth fly being thruſt in, maintained her life longeſt of all, yet at laſt, ſuffering ſome convulſion, ſhe lay unmoved and reſupine. All the flies, after ſome ſtay in the artificial air, being taken out from thence, and expoſed to the common, grew well in a ſhort time.

I MADE the ſame experiments in another receiver half full of artificial air, and in a manner with the ſame ſucceſs; but the flies, in that receiver to which only common air was blown in, recovered the power of motion and their ſtrength in a ſhort time.

June 27. I FOUND one of the receivers, which was wholly evacuated of common air, to be full of artificial air; but it being caſually thrown down upon the ground, ingreſs was thereby afforded to the external air: yet I put a frog into it, which ſeemed not to be very ſick therein.

June 30. MY fourth receiver, by the power of the produced air, ſeemed at length forced away from his cover. I put a frog into it, in manner aforeſaid, and ſhe fell into high convulſions for five minutes ſpace, and then lay without motion. After four minutes were elapſed, I opened the receiver, and taking out the frog, for 46 minutes ſhe remained without motion; but afterwards in four or five minutes more ſhe grew very well.

BY theſe experiments it is evident, that artificial air is very hurtful to the life of animals; but if it be mixed with common air, it doth not ſo readily produce its effects.

EXPERIMENT V.

June 28, 1677. I PUT paſte into four receivers, three of which I cauſed to be wholly exhauſted of common air, but the fourth was left half full of air.

June 29. ONE of the receivers, which were wholly exhauſted, was found full of air newly produced; and a frog being put into it for four or five minutes, had ſtrong convulſive fits; then for one minute it lay ſtill without motion, whereupon I took the frog out, and in five minutes ſhe began to move, and a while after became well again.

I TOOK another receiver, filled with artificial air, and putting a frog into it, ſeven minutes were elapſed before ſhe ceaſed to be convulſive. And afterward, when ſhe had lain one minute there without motion, I opened the receiver, and taking out the frog, found, that ſhe began to ſtruggle and move; yet I judged thoſe motions to be the relicks of her convulſions; for after that, ſhe remained unmoved for a whole half hour and more; yet at laſt ſhe grew well again.

AS for that receiver, from which I had exhauſted only half of the air, it had ſo long regurgitated with produced air, that it is very credible much common air had got out together with it. A frog being caſt into it, ſeemed to be vehemently moved, and convulſive for 10 minutes, as the reſt did, and then ſhe ſeemed quite dead; but after a full minute was elapſed, I opened the receiver, and the frog, being expoſed to the open air, within a quarter of an hour began to recover motion again.

I PUT a frog into a recipient, full of common air, to try, whether, the paſte being now taken out, the frog would continue her life any longer time there?

July 1. IN the afternoon, I found the frog dead; in the morning ſhe was alive and breathed; ſo that ſhe lived about 48 hours.

June 30. I CAST a frog into my fourth receiver, which was wholly filled with artificial air; for ſeven minutes and an half ſhe was vehemently convulſive, and at laſt died; then, after two minutes, ſhe was taken out of the recipient, and yet recovered no motion at all.

July 1. PERCEIVING the frog to remain in the ſame poſture, I threw her away.

WE have a confirmation by theſe experiments, that artificial air is ſo much the more hurtful to animals, by how much the freer it is from common air.

EXPERIMENT VI.

June 30. I INCLUDED paſte in two receivers, and then I exhauſted the air.

July 4. I WOULD have put a ſhrew-mouſe, being taken by the tail, into one of my receivers, filled with artificial air; but the little vermin, with his fore-feet, did ſo catch at the edges of the receiver, that he could not then be thruſt into it; and by this means the receiver, being for a while open, afforded ingreſs to the external air; yet I ſhut it again, till I had bound the legs of the mouſe, and then he was eaſily put in, and there ſuffered vehement convulſions, and after the elapſe of one minute, died: I preſently took him out, and expoſed him to the common air; but his life being wholly gone, no power of motion could be recovered.

THEN I took the other receiver, and putting a ſnail into it, did with ſome wonder obſerve, that he continued to be moved very ſtrongly for a whole quarter of an hour; but afterwards his motion was ſlower, until, about another quarter of an hour being elapſed, he lay ſtill, as if he were dead; but then being taken out of the receiver, and expoſed to the air, in a ſhort time he grew well.

I PUT flies into the ſame receiver; but now it had admitted too great a quantity of external air, for the flies ſuffered no prejudice.

BY this experiment we gather, that artificial air doth kill animals by ſome venomous quality, and not only by the defection of common air; for the ſnails lived a longer time *in vacuo*. See *Art*. VI. *Exper*. III.

EXPERIMENT VII.

I TOOK a receiver, filled with air produced from cherries, and then tranſmitted that air out of that into another receiver, full of common air, in which a frog was kept: matters were ſo ordered, that the water gave place only to the artificial air entering in, and the water itſelf flowed out; and thus the frog, being included in pure artificial air, for a quarter of an hour and more ſuffered convulſions, and at laſt lay ſtill without motion: yet being after taken forth, and expoſed to the open air, ſhe grew quickly well.

IT ſeems probable by this experiment, that air produced from cherries is leſs hurtful to frogs, than that produced from paſte. See *Exper*. V.

EXPERIMENT VIII.

July 9, 1677. I PUT gooſberries into three empty receivers.

July 20. I FOUND one of my recipients ſevered from his cover by the force of the produced air; I caſt a flie into it, which died in one punctum of time; a ſecond flie being likewiſe caſt into the receiver, preſently alſo died: a third flie put into the ſame receiver, ſeemed a little while to be convulſive there; but leſs than a fourth flie, which I included there, which yet before one quarter of a minute was elapſed, lay unmoved. Afterward I diſpelled the artificial air out of the receiver, by blowing, and in a little time the flies grew well.

July 24. I TOOK another receiver, filled with air produced from gooſberries, and putting a ſhrew-mouſe into it, found, that he died there in the ſpace of one half minute.

FROM this experiment it ſeems inferrible, that air produced from fruits is leſs hurtful to animals, than air produced from minerals. For the 20th day of *July* I tried, that a mouſe did not live above a quarter of a minute in air produced out of gunpowder.

EXPERIMENT IX.

July 5, 1677. I INCLUDED paſte in four receivers, having the air exhauſted from them.

July 6. ONE of thoſe receivers, being filled with factitious air, was forced from its cover, which I again ſtopped, yet not ſo ſuddenly, but ſome common air might mix with the artificial: yet I put a ſhrew-mouſe into it, who was preſently highly convulſive, and after one minute and an half remained unmoved; and being preſently taken out, he ſeemed to make ſome convulſive motions, but died notwithſtanding.

July 7. I TOOK a ſecond receiver, filled with artificial air, and having put a little bird into it, I ſuddenly ſtopped it; ſhe preſently fell into convulſive motions, and within a quarter of a minute, or a little more, died; I took her out, but it was too late, for ſhe never ſtirred more.

I BLEW out the artificial air from the receiver, and then, another bird of the ſame kind, being put into it, was very well; yet ſhe ſtaid there four minutes.

July 9. I TOOK a third receiver full of artificial air, and put that bird into it, which in the former experiment had continued well, and yet ſeemed to be lively and ſound; before ſhe had been there a full quarter of a minute, ſhe lay without motion, and being preſently taken out, there appeared no ſign of life in her.

IN the afternoon I put an adder into my fourth receiver, and within two minutes he began to be ill, and to gape and pant; yet he was not wholly deprived of motion till after 24 minutes. Then after ſix minutes more, which made up half an hour, I took the adder out of the receiver, motionleſs as he was, and expoſed him to the free air; yet he did not recover life.

July 10. THE adder remained in the ſame ſtate, and gave no hope of reviviſcence.

EXPERIMENT X.

July 12, 1678. I PUT a bird into a receiver full of air produced out of raiſins of the ſun; ſhe died in ¾ of a minute, and though I took her out preſently, yet ſhe never ſtirred more.

July 18. I LIKEWISE put a ſhrew-mouſe into a receiver full of air produced from raiſins of the ſun; but a thread, left on the edge of the receiver, hindered me from ſtopping it cloſe; yet the mouſe preſently began to be very ill, and after two minutes he lay, as it were, without any motion; yet being taken out, in two or three minutes time he was well again.

EXPERIMENT XI.

Octob. 1, 1678. ABOUT ten of the clock in the morning, I included a ſhrew-mouſe with common air, in a receiver fortified againſt the external air; about 11 the mouſe was brought to ſuch ſtraits, that he could hardly breathe. I threw in another ſtrong and luſty mouſe into the ſame receiver, and preſently put on the ſtopple again: but becauſe the firſt mouſe had conſumed ſome of the air, it came to paſs, that the external air was forcibly impelled into the receiver, and ſo was able to diſpel a great part of the air ſtagnant there: and indeed, when this was done, the firſt mouſe ſeemed to be much better, neither did it die much ſooner than the other; but both of them died about noon. About four in the afternoon, I thruſt a freſh ſtrong mouſe into the ſame receiver; and leſt the external air might again expel the included air, I put him in very ſlowly and leiſurely: the iſſue was, that this third mouſe lived not three minutes entire.

WHENCE we may conjecture, that that portion of air, which hath once ſerved the reſpiration of animals, as much as it could, is no longer uſeful for the reſpiration of another animal, at leaſt of the ſame kind.

EXPERIMENT XII.

THIS day in the morning I put ſo great a quantity of paſte into an empty receiver, that in the afternoon I found the receiver full of factitious air: whereupon I thruſt down a ſnail into it, which preſently frothed very much, and did very often expand and again contract itſelf; but at length after four minutes were elapſed, he ceaſed to move at all; yet I took him not forth, till he had ſtaid in the receiver an whole quarter of an hour, and then, being extracted, he ſeemed as if he had been quite dead; for though he were pricked with a pin, yet he diſcovered no ſign of life; yet after another quarter of an hour, being alſo pricked with a pin, he made a little motion.

I blew out the factitious air from my receiver, and then thruſting in another ſnail after the ſame manner as I did the former, he was very well in the receiver, and did not froth at all.

We have a confirmation by this experiment, that factitious air is a greater enemy to animals, than a *vacuum* is.

Experiment XIII.

June 22, 1678. This day, in the morning, I put green peaſe into an empty receiver, and towards evening the mercury had almoſt attained to the height of 10 digits.

June 23. The height of the mercury was almoſt 30 digits.

June 24. The mercury did not as yet exceed 30 digits in height: the cover did no longer ſtick to the receiver, yet hitherto nothing had eſcaped out of it.

June 26. I included the ſame peaſe in the ſame empty receiver.

June 29. When I now found, that the receiver was filled with factitious air, I thruſt a ſnail into it, who put forth much ſpume or froth, and did very often expand and contract his horns; but after ſix minutes were elapſed, he lay ſtill, as if he had been dead, for two or three minutes; then the receiver being opened, and the ſnail taken out, moved himſelf a little, if he were pricked: whence it ſeems to follow, that air produced from peaſe is leſs prejudicial to ſnails than air from paſte. See *Exper*. XII. I blew new air into the receiver, and a ſnail then put into it did very well.

In this experiment it ſeems obſervable, that peaſe do quickly produce air *in vacuo*; but in the wonted compreſſion of air they generate but little.

ARTICLE VI.

Animals in vacuo.

Experiment I.

June 22, 1676. I put a butterfly into an empty receiver, and it was almoſt three hours before ſhe was wholly deprived of her faculty of motion: at length, perceiving him to lie unmoved, I let in the air into the receiver, and in a little time the butterfly recovered his motion. Then I bound him by one of his horns with a thread, and ſo hanged him in the receiver, and then he was carried very freely from one part of it unto the other, by clapping his wings; but after the air was extracted, the clapping of her wings was in vain, for ſhe could not move the thread in the leaſt, from being perpendicular.

Experiment II.

July 12, 1676. Yesterday I put two flies into a receiver, in which I left $\frac{1}{3}$ of air, *i. e.* as much as would ſuſtain 10 digits of mercury; the biggeſt of the flies ſeemed to die preſently, but the other, which was a a ſmall bodied one, lived almoſt twenty four hours.

When both the flies lay as if they were dead, I ſuffered ſome air to enter in, till the mercury was 15 digits high; and then the leſſer fly began to move her feet, but the other continued ſtill without motion.

Hence it appears, that air highly rarefied may ſerve for inſects to breath in, and that it doth not kill them ſo ſoon as artificial air.

Experiment III.

May 1. I put two ſnails into an emptied receiver, and for an whole hour they ſeemed to be well enough, and crept up to the top of the receiver; but in two hours time, they fell down from thence, and lay without motion.

Six hours after they were firſt put in, I took them out *è vacuo*, and within half an hour they began to move a little. During the time they were included, they produced near as much air as ſufficed to ſuſtain the mercury in the height of $\frac{1}{4}$ of a digit.

These ſnails lived longer *in vacuo* than the others included in artificial air. *Art*. V. *Exper*. VI.

Experiment IV.

Auguſt 12, 1676. I put fly-blowings, or the eggs of flies, into an empty receiver, to try, whether they would produce worms there or no.

Auguſt 14. I saw the worms were formed, but the air had crept into the receiver, ſo that it could ſuſtain 15 digits of mercury.

Hence it appears, that inſects may be produced, and may live, if not *in vacuo*, yet at leaſt in air very highly rarefied. See *Exper*. VI. and VIII.

Experiment V.

March 17, 1677. I put two equal quantities of frog-ſpawn into two veſſels of glaſs, of equal bigneſs; I left the one included in an empty receiver, expoſed to the ſun; but the other, being in a receiver full of common air, I fortified againſt the acceſs of the external air. The frog-ſpawn *in vacuo* did all ſwell into bubbles.

May 2. No frogs were produced in either receiver, and that ſeed or ſpawn, which was kept *in vacuo*, remained ſtill full of bubbles; but about three days ago all the bubbles vaniſhed, and the ſpawn was changed into a certain green liquor.

July 2. Our receivers remained in a window, expoſed to the noon-day ſun; and ſo ſome water, that was mixed with the frog-ſpawn, all *in vacuo*, and the very ſpawn itſelf, was elevated into vapours, and afterwards ſticking to the ſides of the receiver, out of its own veſſel, was there condenſed; but the veſſel kept in the common air, ſtill contained all its water, together with the ſeed or ſpawn.

Experiment VI.

Auguſt 16, 1677. I put flies-eggs into an empty receiver.

Auguſt 29. When no worms were produced out of them, I gave admiſſion to the air to enter into the receiver, and left all things in the ſame poſture, to try, whether the eggs had loſt their faculty of producing worms.

Sept. 9. The eggs produced nothing.

This experiment, if it be compared with *Exper*. IV. ſeems to ſhew, that inſects may be generated, and may live in air highly rarefied, but not at all *in vacuo*.

Experiment VII.

June 15. I shut in a frog in an emptied receiver, at about ſeven of the clock in the evening; about nine the frog died.

June 16. I repeated the ſame experiment, and again perceived, that the dead frog, in two hours ſpace, had produced ſome air, rather than conſumed it.

June 18. The frog, left hitherto *in vacuo*, was ſwollen very much; but the air now entering, made her far more flaccid and lank, than ſhe was wont to be.

We are inſtructed by this experiment, that a receiver void of artificial air, is leſs hurtful to the life of ſuch kind of animals. See *Exper*. IV. and VII. of *Art*. V.

Experiment VIII.

Auguſt 3, 1678. I put fly-blowings ſticking to fleſh, into an emptied receiver.

Auguſt 12. No worms were generated from them.

Auguſt 15. Perceiving no change in the eggs, I opened the receiver, to try, whether they would yet be generated in the free air.

Sept. 15. Nothing was produced from them.

We have a confirmation by this experiment, that animals, which may be generated and live in highly rarefied air, yet are killed *in vacuo*. See *Exper*. IV.

Experiment IX.

Auguſt 22, 1678. I included vinegar full of ſmall eels, or vinegar-worms, in an emptied receiver.

Auguſt 29. The worms were ſtill moved, yet they were fewer than in the beginning.

Sept. 6. Yesterday ſome of thoſe worms did ſtill move in our vinegar, but this day I could not ſee one; whereupon taking a microſcope, I found them all dead: but in the vinegar, which I had left in the open air, the eels made as briſk motions as at the beginning.

Hence it appears, that thoſe, even very diminutive animals, are alſo affected with the preſence and abſence of the air.

Article VII.

Fire in compreſſed air.

Experiment I.

May 14. I took a perfumed cone, of that nature, that being once kindled in the free air, it is wont by degrees wholly to be conſumed, and put it into a receiver firmly ſtopped with a ſcrew; and I intruded air into it, till the mercury came to 120 digits above its wonted height, and then putting to my burning glaſs, I kindled the cone, which preſently darkned all its receiver with ſmoke, and after ſome time $\frac{7}{8}$ parts of 1 digit thereof in length were reduced to aſhes: yet taking out the cone, and blowing away the aſhes, I found only the ſuperficies thereof conſumed, but the inner parts were untouched.

I included another cone of the ſame ſort in a much greater receiver, but I did not compreſs the air therein: the cone, fired by the ſame burning-glaſs, was not taken out, till all the fumes were abated and fallen down; yet much leſs of this cone was burnt than of the other.

Experiment II.

May 19. I weighed a perfumed cone exactly, and then firmly included it in a receiver with common air, and I kindled it by the help of my burning-glaſs. When the fumes were condenſed, I took the cone out of the receiver, and weighed it again; the loſs of its weight was almoſt one grain. Then I got me many pieces of paper, each of them of the ſelf-ſame weight, which I preſume to call paper-grains.

Afterwards the ſame cone, obſerving the ſame circumſtances, was again included and kindled; but firſt I had intruded air into its receiver, as much as could ſuſtain 90 digits of mercury: and thus, by means of a pair of ſcales, I found the loſs of weight this time was four times more than of the former, for the cone was lighter by four paper-grains.

From this experiment it ſeems to follow, that the conſumption of matter is ſo much the greater, by how much the greater quantity of air is contained in the receiver.

Experiment III.

May 17, 1677. I included a perfumed cone in a receiver firmly ſtopped by the help of a ſcrew; and, the air being compreſſed to ſuſtain 60 digits of mercury above its wonted preſſure, I ſet fire to it with my burning-glaſs; the cone being afterwards taken out, had loſt three paper-grains and an half in weight.

I REPEATED the ſame experiment, but in air ſo compreſſed, that the mercury reached to 120 digits above the wonted preſſure: then the cone was 7 $\frac{1}{4}$ paper-grains lighter; and ſo, though the quantity of the air was not double, yet the conſumption of the matter by the fire was more than twice as much as that was in the former experiment.

May 17. I ITERATED the ſame experiment in air compreſſed to ſuſtain 97 digits of mercury, and then the loſs of weight ſeemed to be ſix paper-grains.

BY all theſe experiments we are taught, that the matter is ſo much the more conſumed by the fire, by how much the compreſſion of the air in the receiver is the greater; yea, the conſumption ſeems to have a greater proportion to the conſumption, than the compreſſion hath to the compreſſion.

May 18, 1677. I INCLUDED a perfumed cone as before, in a receiver ſeven times larger than that, which I uſed in the former experiments, and I immitted no air at all into it. The cone kindled there loſt 3 $\frac{1}{4}$ paper-grains of its weight, and no more; whereas, in the ſame quantity of air, if it had been reduced to a fifth part of its ſpace, the cone would have loſt 10 grains, *viz.* by obſerving the proportion of the conſumption made before in air, ſuſtaining mercury to 120 digits above its accuſtomed height, (*i. e.*) air reduced to a fifth part of its ſpace.

FROM this experiment it ſeems to follow, that the ſame quantity of air, if it be reduced to leſs than its accuſtomed ſpace, on that account alone cauſeth a greater conſumption, than if it had remained in its wonted expanſion.

EXPERIMENT IV.

May 19, 1677. I REPEATED the experiment laſt deſcribed, in the ſame receiver, cloſely ſtopped with a ſcrew, that nothing might go out or in. The cone loſt one paper grain and a quarter only of its weight; whence I ſuſpect that it was not well kindled.

May 21. I MADE the ſame experiment, after the ſame manner. This day the cone was lighter by four paper-grains; whence I more certainly collected, that it was not well ſet on fire in the former experiment.

May 23. I REPEATED the ſame experiment twice, but do ſuſpect, that the cone was not well kindled, ſeeing at one time it loſt only $\frac{3}{4}$, and at another time one paper-grain of its weight.

May 24. I TRIED the ſame experiment again, and this day alſo the loſs of weight was found only one paper-grain and a quarter. Then I opened my receiver, and having wiped and cleanſed away the ſoot, I iterated the experiment, and then the cone took fire very well, for the loſs of its weight amounted to ſix paper-grains and an half.

I TRIED the ſame experiment again in an uncleanſed receiver, and then the cone loſt only three paper-grains in weight.

May 25, I ITERATED the ſame experiment in a receiver well waſhed, and the cone was lighter by ſix paper-grains and an half.

I MADE the ſame experiment in the like manner, and in a well cleanſed receiver, and the cone loſt ſeven grains and an half of its weight.

I TRIED the ſame experiment again, in an unwaſhed receiver, and then I could not ſufficiently kindle the cone.

May 26. I TRIED the ſame experiment in an unwaſhed receiver, about the middle of the day, the ſun being clear and clouded with no miſts; and I removed not my burning-glaſs from kindling the cone a long time, ſo that it took fire very well, and became eight paper-grains lighter.

BY theſe experiments it is manifeſt, that the quantity of a cone to be conſumed in the ſame quantity of air, is not fixed and certain, but ſometimes greater, ſometimes leſſer, as the cone ſhall be more or leſs kindled: beſides, the imperfect mixture of the matter may cauſe ſome difference; yet, it ſeems certain, that fire is more eaſily kindled in compreſſed air, than in common; and the conſumption will be the greater in a certain quantity of air, if that air be reduced into a narrower ſpace, than if it enjoyed its wonted expanſion.

EXPERIMENT V.

May 22. I PUT a perfumed cone into a receiver made for compreſſing the air; and intruding the air till the mercury ſtaid in 30 digits above its wonted preſſure I kindled the cone, and found its weight to be abated 1 $\frac{3}{4}$ of a paper-grain.

May 23. I MADE the ſame experiment again, after the ſame manner, and in effect, with the ſame ſucceſs.

I TRIED the ſame experiment again, but the cone took not fire well. Whence we we have a confirmation, that fire is more eaſily kindled in air much compreſſed, than in common air, or that, which is but a little condenſed.

I ITERATED the ſame experiment, and after I had removed my burning-glaſs from kindling the cone, whilſt I was intent to ſee whether the cone would proceed to be conſumed, the receiver brake into 100 pieces, ſome of which ſtruck my head, and wounded it: which paſſage I mention, that ſo no man may be confident his glaſs will not break whilſt he is about theſe experiments, becauſe he hath found, that at other times it hath reſiſted a greater preſſure. For this very glaſs of mine, had contained air four times more compreſſed, very well. See *Exper.* III. Yea in *Exper.* VI. of *Art.* II. it had reſiſted air ſuſtaining 198 digits of mercury above its wonted height; yet, now it was broken by a preſſure more than ſix times leſs: and therefore, whilſt a man looks into ſuch receivers, his head had need be fortified with ſome perforated or pellucid muniment and defence to preſerve it from a blow.

ARTICLE VIII.

Fire uſed to produce air.

EXPERIMENT I.

June 4, 1676. I BURNT paper, beſmeared with ſulphur *in vacuo*, and found, that it produced ſome air, which air was not at all diminiſhed for two whole days.

THAT air is to be aſcribed to the paper, for no air is produced out of ſulphur alone.

EXPERIMENT II.

June 15. I BURNT harts-horn *in vacuo*, and found, that the fumes iſſuing therefrom did contain ſome air in them.

THESE two laſt days, I iterated the ſame experiment, and always obſerved, that air produced from harts-horn, was in a ſhort time in part deſtroyed; but that, which preſerved the elaſtic nature of air for a full hour after the burning-glaſs was removed, ſeemed afterwards not to loſe it at all.

June 19. I TOOK the harts-horn out of the receiver, and found no volatile ſalt, but only a fœtid oil to be produced therefrom.

EXPERIMENT III.

June 21. I BURNT amber *in vacuo*, and at firſt I could not find, that the fumes did aſcend above the height of one digit; and yet in a receiver full of air, they would be carried up to the top of the receiver, and from thence be reflected downwards; yet afterwards, even in the vacuum itſelf, the fumes reached almoſt to the top of the receiver, but the mercury was not at all changed in its gage.

June 22. THIS night a great deal of that water, in which I had immerſed the receiver, found a paſſage into it, though the cover was ſo well fitted to the aperture, that I never perceived any water to get in betwixt them before. Hence a ſuſpicion aroſe in me, that ſome volatile ſalt had probably attracted (if I may ſo ſpeak) the aqueous parts, by reaſon of the congruity betwixt them.

July 8. I STILL kept the receiver immerged in water, but no more water entered in, as if the ſalts being waſhed away, the external water, being deſtitute of aſſiſtance, could no longer creep in: but that agreement between the fumes of the amber and the parts of the water had need of a confirmation by a great many more experiments.

HENCE it appears, that amber produceth no air, no not though it be burnt.

EXPERIMENT IV.

Jan. 18, 1677. I PUT two drachms of camphire into an empty receiver, and the commiſſure of the cover with the receiver being fortified againſt external air, I put the camphire on a digeſting furnace.

Jan. 19. THE camphire was ſublimated into flowers, but no air was produced.

EXPERIMENT V.

May 24, 1676. I INCLUDED *ſulphur vivum* in an exhauſted receiver, and melted it by the help of my burning glaſs, but found, that the fumes, produced therefrom, did contain no air in them, becauſe the mercury did aſcend to the aperture of its gage, as it uſeth to do while the receiver is evacuating: yet when the receiver was cooled, the mercury returned to its former height; and therefore I think that change proceeded only herefrom, becauſe the air, included in the ſealed leg of the gage, was rarefied, and drove the mercury into the other part.

EXPERIMENT VI.

July 19. HAVING included paſte nine days ago *in vacuo*, and perceiving, that it now contained no more air, I endeavoured to fire it with my burning glaſs. The ſubſiding fumes had tinged the ſuperficies of the paſte with a curious yellow colour; and beſides I conjectured, that ſome air was produced, becauſe the receiver, which before was ſtraitly joined to its cover, was now with eaſe plucked therefrom.

ARTICLE IX.

Concerning the production of air in vacuo.

EXPERIMENT I.

Sept. 9, 1676. I EXHAUSTED the air out of a receiver half full of dried grapes, and fortified it againſt the external air.

Sept. 10. In 24 hours time the height of the mercury was $\frac{1}{2}$.
12. In two days time the aſcenſion of it was $\frac{1}{2}$.
14. The aſcenſion of the mercury was $\frac{3}{8}$.
17. The aſcenſion of it was $\frac{3}{8}$.
22. The aſcenſion of it was $\frac{5}{8}$.
27. The aſcenſion was $\frac{5}{8}$. The height three digits.
Octob. 11. The height of the mercury was now about ſix digits.

Sept. 9, 1676. I PUT dried figs into a receiver, and filled about half of it with them, and then I extracted the air, till the mercury ſtaid in the height of three digits.

Sept. 10. No air was produced.

Sept. 17. PERCEIVING no air to iſſue out of the figs, I opened the receiver.

BY this experiment we learn, that dried fruits, put into an exhauſted receiver, do produce very little air with regularity.

Experiment II.

Aug. 5, 1676. I included pears and apricocks *in vacuo*.

Aug. 6. In 18 hours time the mercury reached two digits; In 10 hours more it reached the third digit. Its height was three digits.

Aug. 7. The height of it was five digits.
8. The height of it was 6 ½.
9. In 14 hours ſpace the mercury mounted ½. Its height was 7 ½.

10.	The height of it was	8 ½
11.		10 ½
12.		12 ½
13.		14 ¼
14.		16
15.		18
16.		20
18.		25
19.		29
20.		31 ½
21.		32 ½
22.		34
23.		35
26.		38 ½

29. The height of the mercury was 41.
Sept. 1. The height of the mercury was 42 ½.
4. The height of it was 44.
7. The three days laſt paſt being hotter than the foregoing, the aſcenſion of the mercury was 2 ¼. Its height was 46 ½.
10. The height of the mercury was 47 ½.
13. The mercury was depreſſed; its height was only 44 digits.
23. The mercury was by degrees again mounted to the 48th digit.
27. The height of the mercury was 50 ½.
Nov. 5. The mercury aſcended by degrees to the height of 52 ½.
28. The apricocks were reduced to water; the ſkin was ſevered from the pulp, yet no more air was produced.

Jan. 10, 1677. Whilst it was a very hard froſt, the mercury came to the height of 57 digits: but when the thaw came, it was depreſſed to 23. Whether the ſtrength of the froſt opened ſome way for the air to get out, I know not.

March 3. The mercury could aſcend no higher, becauſe the air was got out. This day I found the receiver tumbled on the ground, and the apricocks, when the froſt was broke, were putrified, and had loſt their colour.

From this experiment it ſeems to follow, that apricocks do produce air almoſt as eaſily in their wonted preſſure, as *in vacuo*.

Experiment III.

June 20, 1676. I put four cherries into two empty receivers, and obſerved altogether the ſame circumſtances in them both; ſave, that in the one, the cherries were whole, in the other, cut aſunder. In two hours ſpace the whole cherries had impelled the mercury into the gage to the height of 10 lines; and the diſſected cherries to about 20.

June 21. In 24 hours ſpace the mercury, which was in the receiver containing the whole cherries, came to the height of three digits; but in the other receiver the mercurial gage was ſpoiled.

June 26. The whole cherries had not yet produced ſo much air, that could ſuſtain 15 digits of mercury; but the diſſected cherries had wholly filled their receiver with air.

July 9. This day the receiver of the whole cherries was removed from his cover: I did eat one of the cherries, and its taſte ſeemed pleaſant enough. I included the reſt again *in vacuo*; many of them were broke, and in one hours ſpace they impelled the mercury to aſcend to the height of about two digits.

July 10. These laſt 24 hours the mercury aſcended not; whether the gage was prejudiced, I am not certain.

July 15. This day I found the cover ſevered from his receiver, and ſo it was clear, that the gage was ſpoiled or hurt.

This experiment gives us a probable conſequent, that ſome diſſected fruits do ſooner produce their air than whole and undivided ones.

Experiment IV.

June 9, 1676. I put cherries (not acid ones) into an empty receiver, and within one hour I found as much air produced from them, as ſufficed to ſuſtain ¼ of a digit of mercury.

June 10. In 18 hours the mercury ſeemed to have come to the height of 11 digits.

June 11. Our fruits produced air leſs and leſs copiouſly; ſo that this day, towards the evening, they came not up to the height of 15 digits.

June 12. Now the mercury was a little higher than 15 digits.
13. The height of the mercury was 22 digits.
16. The mercury yet came not up to 30 digits.
18. Perceiving no more air to be produced from my fruits, I opened the receiver.

Such a ſmall production of air ſeemed very obſervable to me, becauſe I had found by experience, that fruits of the ſame kind in *France* had filled their receiver in two days time: it may probably come to paſs, that fruits of the ſame kind, in ſeveral countries, may differ much amongſt themſelves.

Experiment V.

June 12, 1676. I put cabbages cut in pieces into an empty recipient with a mercurial gage, and in one hours ſpace the mercury had made one line.

June 13. The mercury was now come almoſt to the height of 12 digits.

17. The mercury was come almoſt to the top of its gage, and the receiver being opened, I found the cabbages little altered.

19. The cabbages being left two days in the open air, were wholly corrupted and blackiſh. I put them again *in vacuo*, to try, whether the putrefaction begun would promote, or elſe retard the production of air.

19. The mercury in half an hour ran up ½ of a digit.

22. For three whole days the mercury got higher only 10 lines. Its height was 1 and ½ of a digit.

23. Finding, that the cabbages produced no more air, I took them out of the receiver: their ſmell was very bad.

HENCE a ſuſpicion aroſe within me, that bodies, when they putrefy, have already produced almoſt all their air.

EXPERIMENT VI.

May 29, 1676. I TOOK pieces of orange weighing four ounces, and put them into a receiver capable of holding 10 ounces of water, and I exhauſted the air.

June 10. THIS day the receiver was removed from his cover by the force of the produced air; ſo that I took out the oranges, and preſently put them into another empty receiver capable of containing eight ounces of water, and the mercury, within half an hour, was elevated to the height of one half digit.

June 13. THAT ſudden aſcenſion of the mercury was not durable, for it yet came not to the height of two digits.

June 16. THE mercury, the laſt 24 hours, aſcended about three lines.

June 21. THE mercury, theſe laſt 24 hours, did not aſcend the ſpace of one line.

July 18. I PERCEIVED no more alteration was made in the height of the mercury; but ſome mouldineſs appeared, though I am certain, that no air from without had found any ingreſs into the receiver.

EXPERIMENT VII.

April 27, 1676. I PUT a tulip into an empty receiver with a mercurial gage; but before it was fortified againſt the external air, ſome air had got in, enough to ſuſtain two digits of mercury.

May 2. THE tulip, which firſt ſeemed ſtriped with ſundry colours, was now wholly changed into a dark red, and was moiſt: it produced very little air.

EXPERIMENT VIII.

April 22, 1676. I PUT half of a lemon into an empty receiver, with a mercurial gage ſo ſhort, that the mercury could not run up the ſpace of three digits.

April 24. In two days ſpace the mercury came to the height of one digit and a half.

25. The mercury was now two digits high.

27. Yeſterday the mercury made four lines, but this day only one.

29. The two laſt days the mercury mounted higher by one line.

May 3. In four days ſpace the mercury aſcended one line and a little more.

May 5, 1677. THE mercury came to the top of its gage, yet no air got out; but the lemon was little altered.

Jun. 1, 1678. As yet no air eſcaped out of the receiver; but the lemon had contracted a yellow colour, and moiſture therewith.

EXPERIMENT IX.

March 16, 1677. I PUT two apples of the ſame ſort in two empty receivers; one of the apples began to putrify before, the other was only bruiſed with a few blows.

May 15, 1677. As yet the fruits were in very good caſe; but this day that apple, which was bruiſed, appeared wholly rotten, and the receiver was forced from his cover; the other apple remained without any change.

Aug. 20. 1677. THAT apple, which before began to be rotten, ſuffered no farther alteration; but this day finding, that the receiver was pulled from his cover, and fearing leſt the apple would be ſpeedily putrified, I took it out: its taſte was grateful, but ſubacid, as if it had been fermented; but the pulp inclined to the conſiſtence of meal.

FROM this experiment it ſeems to be confirmed, that fruits have produced the greateſt part of their air, when putrefaction begins to alter them; ſeeing the putrid apple did not fill its receiver but in a much longer time than the other apple. See *Exper.* V. of this article.

EXPERIMENT X.

May 17, 1676. I POURED two equal quantities of milk into two glaſs receivers of equal bigneſs; the one I left in the free air, the other I included to be kept in an emptied veſſel with a mercurial gage.

May 18. THE cream did ſwim on the top of that milk, which was left in the free air; but that, which was *in vacuo*, was only covered with bubbles, and the gage was not changed at all.

May 19. THE bubbles ſwelled more and more, and the mercury in the gage was a little higher.

May 20. THE bubbles *in vacuo* ſwelled yet more, and that milk ſeemed curdled; but the other, in the free air, was manifeſtly curdled. The mercury *in vacuo* came almoſt to the top of its gage.

May 22. THE milk *in vacuo* proceeded to generate air more and more, and now it evidently appeared to be curdled; whence it is manifeſt, that the coagulation of milk, when the air is taken away, is retarded. Now almoſt all the bubbles were broke.

June 20. THE milk *in vacuo* was no longer covered with bubbles, and remained ſtill coagulated in the ſame ſtate. But the milk in the free air ſtank filthily, and was full of worms: when it was put on the engine, and the air extracted, it did emit many very great bubbles for a long time; and the worms did move themſelves very vehemently, but not one of them died in four hours ſpace.

May 19, 1677. THREE or four months ago, ſome whey *in vacuo* was poured out of a veſſel into a receiver, and it ſeemed clear and limpid like water; yet there was whey enough left in the veſſel to ſeparate the butyrous from the caſeous part at a ſufficient diſtance.

THIS day the milk ſtagnant in the receiver ſeemed to have got out of it; ſo that it is clear, that the air in the receiver was of greater force than the external air, for the cover alſo was forced from the receiver. Towards night I took that milk out of the receiver, and found it to be acid both in ſmell and taſte, yet it was not unacceptable to the palate; but after a ſhort time, the whey, which hitherto had remained limpid between the caſeous and butyrous part, began to diſappear, and to be blended with the reſt.

May 24. THIS day the butyrous part was wholly vaniſhed, though as yet it had ſuffered no ſenſible mutation; but the milk began to ſmell amiſs.

June 1. OUR milk had not yet contracted the worſt of ſmell, neither had it produced any worms, but it grew dry by degrees; and this night the mice eat it up, as perhaps they had done the butyrous part before.

THIS is the ſtory of my preſerved milk, in which theſe four things ſeem moſt obſervable. Firſt, that the coagulation of milk, when air is extracted therefrom, is ſomewhat retarded. Secondly, the weight of butter, or of whey, or cheeſe, is not the ſame in the air, as it is *in vacuo*; for in the air they are mixed one with another confuſedly: but *in vacuo* one ſwims on the top of the other. Thirdly, the putrefaction of milk, when air is extracted, is hindered or very much retarded. Fourthly and laſtly, milk, by long continuance *in vacuo*, is made unfit to generate worms, even in common air.

EXPERIMENT XI.

Sept. 5, 1677. I TOOK the ſame receiver and the ſame veſſel, which I uſed before to preſerve milk *in vacuo*, and I included urine therein, after the ſame manner as I had done milk before. The quantity of urine was three ounces and three drachms, or thereabouts; and the receiver was only capable of holding 10 ounces of water.

Sept. 7. THE mercury reached to the height of almoſt two digits.

Sept. 8. THE mercury was this day ſomewhat higher than yeſterday.

Dec. 5. THE mercury aſcended not above three digits in height, and for the whole month paſt was not changed at all. The urine ſeemed not all to be altered.

Dec. 6. I SET other urine under a receiver, not fortified againſt the external air.

Dec. 16. THE urine *in vacuo* ſtill kept unaltered, but the other in 10 days time ſeemed turbid, and to have contracted ſome mouldineſs in its ſuperficies.

THIS experiment, compared with the former, gives us a probable inference, that urine, which is an excrementitious humour, contains leſs air in it than milk, which is alimental.

MOREOVER the efficacy of the air to corrupt urine ſeems very obſervable.

EXPERIMENT XII.

May 19. I TOOK paſte very much diluted, and without leaven, and put it in a glaſs veſſel into an empty receiver; and though the veſſel, which contained it, were not half full, before all the air was exhauſted, yet the paſte had ſwollen above the brims of the veſſel.

May 20. THE paſte continued to ſwell more and more, and was interſperſed with many cavities.

May 22. THIS day the paſte was much more tumid than before, and much air was generated therefrom.

May 23. THIS day in the morning I found the cover ſevered from his receiver, by the force of the produced air, and ſome of the paſte was ſpread above the edges of the receiver; yet its ſwelling was ſomewhat abated. In the afternoon, its tumidneſs was much more abated, yet it took up twice more room than it did before it was put into the receiver. The taſte of it was not acid, and therefore I think that bread, thus made, is very light.

EXPERIMENT XIII.

July 20, 1676. I TOOK a quantity of beef, and put it into an exhauſted receiver fortified againſt the external air; and likewiſe I put another equal quantity of beef into a receiver, neither exhauſted nor cloſely ſtopped.

July 21. IN thirty hours ſpace, the exhauſted receiver was all filled with air, ſo that I ſuſpected ſome air had got in; and therefore I included the ſame beef again, and ſo cloſed it, that there was no fear of the ingreſs of any external air.

July 22. IN fourteen hours ſpace the mercury came to the height of 15 digits.

July 25. FOR three whole days and more, the beef did not produce ſo much air as would fill one half of the receiver.

July 26. THIS day the receiver was ſevered from his cover; and in one hour's ſpace, I perceived, that the beef, being again included *in vacuo*, had produced air, which ſufficed to ſuſtain 10 digits of mercury.

July 28. I found the receiver again filled with air, and re-exhauſting it, much air was in a ſhort time again produced from the beef.

July 30. The receiver being again filled, I included the beef again *in vacuo*, and found, that the air produced from it in one hour's ſpace was able to ſuſtain 10 digits of mercury.

Aug. 1. The receiver being this day filled again, the beef ſtank ſo filthily, that we threw it out of doors.

Hence it appears, that fleſh, whilſt it putrifies, doth produce much more air, than before it putrifies; but it is otherwiſe with fruits. See *exper.* 9. of this artic.

EXPERIMENT XIV.

July 18, 1676. I put ſome gooſberries, which I had kept long in receivers to produce air, into a vacuous receiver.

Within half an hour the mercury aſcended to the height of one digit.

In an hour and half's time, the mercury mounted to another digit.

July 19. In twenty-four hours time the receiver was almoſt all filled with air.

July 20. The cover was forced from his receiver, and much juice had run out of the receiver.

July 29. I left the ſame gooſberries in a receiver, not hitherto fortified againſt the external air; but this day I included them again *in vacuo*, to try, whether they could produce any more air.

July 30. In ſixteen hours time, the gooſberries drave up the mercury a digit and $\frac{1}{2}$ into the gage.

July 30, 1677. The gooſberries could not wholly fill the receiver, and they always remained in the ſame ſtate; but a while ſince they had almoſt loſt their red colour, and inclined to white.

From this experiment it ſeems to follow, that theſe fruits, after they have produced all their air, admit very little alteration; as if that air itſelf were the cauſe of corruption.

EXPERIMENT XV.

Aug. 23. I put pears into a *vacuous* receiver with a mercurial gage; and before the receiver could be well fortified againſt the ingreſs of the air, the mercury was come to the height of one digit and an half.

In two hours ſpace the mercury aſcended four digits; its height was almoſt ſix.

Aug. 24. The height of the mercury was twelve digits.

Aug. 25. The height thereof was ſixteen.

Aug. 26.	The height of it was	18
27.		21
28.		23
31.		30
Sept. 1.		32
2.		35
3.		38 $\frac{1}{3}$
4.		44 $\frac{1}{3}$
5.		45 $\frac{1}{3}$
6.		50

Sept. 7. The height of it was the ſame, becauſe ſome air had eſcaped; but I prevented that for the future.

8. The height of the mercury was 53$\frac{1}{2}$.

9. The height of it was 54 $\frac{1}{2}$.

10. The height of it was 58.

Sept. 12. Yeſterday the mercury perſiſted in the ſame height; but this day it ſeemed to be depreſſed: whence I conjecture, that ſome air had got out. The height of it was 53 $\frac{1}{2}$.

Sept. 13. I tranſmitted the air into another receiver: the height of it was 32 $\frac{1}{2}$.

Sept. 16. I perceived, that the air had got out; and opening the receiver, I found the pears very rotten.

These pears produced their air irregularly enough, ſometimes quicker, ſometimes more ſlowly.

EXPERIMENT XVI.

Sept. 17. I put dried plums into an evacuated receiver.

Sept. 19. The mercury ſeemed to have aſcended a little.

Sept. 22. I perceived not that the height of the mercury was any more altered.

Nov. 8. When I ſaw, that the plumbs produced no more air, I opened the receiver.

By this experiment we have a confirmation, that dried fruits are very unfit to produce air.

EXPERIMENT XVII.

Sept. 28. I put freſh nut-kernels, cut into pieces, having thrown away their ſhells, into an evacuated receiver, with a mercurial gage.

Sept. 29. The mercury aſcended a little.

30. The height of it was two digits.

Octob. 5. The mercury proceeded to aſcend by degrees: the height of it exceeded ſix digits.

Octob. 15. The height thereof was ten digits.

Octob. 22. The height of it was fifteen.

Nov. 28. The mercury was come to the height of twenty digits, or a little more; but this day the receiver was caſt down and broken, and the nut-kernels thrown about: they were kept very well, both as to colour and taſte.

Hence we may conjecture, that air without ſenſible putrefaction may be produced from fruits, even of an hard conſiſtence.

ARTICLE X.

Concerning the production of air above its wonted preſſure.

EXPERIMENT I.

I Included new peaſe in a receiver, with a glaſs full of raiſins of the ſun bruiſed, and mixed with water; I did not exhauſt the air.

Towards evening the mercury had mounted to twelve digits; but a great part of that air was produced from the raiſins, not from the peaſe.

June 22. The height of the mercury was 49.

June 24.	The height of it was	78
25.		90
26.		90
28.		100

The peaſe did, as it were, ſweat, and grow yellow.

June 30. The height of the mercury was 119.

July 1. The mercury aſcended not, yet no air eſcaped out.

4. The height of the mercury was 124.

7. The height of it was 140.

July 10. The height remained the ſame, but the liquor, which diſtilled or ſweat out from the peaſe, got out.

12. New liquor was produced from the peaſe, but the mercury continued in the ſame height.

July 13. The liquor got out of the receiver, and ſome air beſides; whereupon I ſet the ſcrew, and new liquor being in a ſhort time collected did fortify the cover within.

July 15. This day the receiver was broken in pieces; but the peaſe being ſofter than ordinary, were eaſily ſtript of their huſks, as if they had begun to be boiled: they kept their ordinary taſte.

Experiment II.

Sept. 15, 1676. I put unripe plumbs into a vacuated receiver; but before the receiver could be guarded againſt the external air, the mercury had already aſcended to the height of one digit.

Sept. 16. In twenty-four hours time the mercury ran up five digits; its height was ſix digits.

Sept. 17. The height of the mercury was eight.

Sept. 18.	The height of it was	10
19.		12
20.		14
22.		18
23.		18
24.		19
26.		23
28.		26

Octob. 1. The height of the mercury was 30

4. The height of it was 31: it was ſomewhat cold.

Octob. 5.	The height of it was	32
7.		33
9.		33 ½
11.		Same.

Octob. 15. Theſe two laſt days, the cold being abated, the mercury aſcended more ſpeedily: its height was 37.

Octob. 17.	The height of it was	38
19.		39 ½
22.		41
26.		43
29.		45
Nov. 2.		46
5.		47
20.		53

In this experiment, the air ſeems to be produced ſometimes regularly enough, and at other times anomalouſly.

Experiment III.

July 6, 1676. I put gooſberries into an emptied receiver; but before it could be guarded againſt the external air, it had entered in, and impelled up the mercury to the height of half a digit; and afterwards in half an hour, the air produced from the gooſberries had impelled it up to another ſemi digit.

In ſeven hours time the mercury aſcended four digits higher: it ſtaid in five.

July 7. In fourteen hours ſpace the aſcenſion of the mercury was two digits and ½.

In ten hours ſpace the aſcenſion of it was 2 ½.

July 8. In fourteen hours the aſcenſion of the mercury was 1 ½.

In ten hours the aſcenſion of it was two digits.

July 9. In fourteen hours the aſcenſion of the mercury was 2 ½.

In ten hours its aſcenſion was 1 ¼.

July 10. In fourteen hours the aſcenſion of it was 1 ½.

In ten hours the aſcenſion of it was three.

July 11. In twenty-four hours the aſcenſion of the mercury was four.

July 12. In twenty-four hours the aſcenſion of the mercury was four.

Now the mercury was brought to its wonted preſſure.

July 13. This day in the morning, I found the cover to be broken; and becauſe it was faſtned by a ſcrew, that it might not be ſevered from the receiver, I ſuſpected, that it was broken by the force of the internal air: I ſubſtituted another cover in its place.

July 14, 15, 16, 17, 18. I perceived no change in the height of the mercury, becauſe the cover was not exactly ſhut; and therefore I took out the fruits, and put ſome part of them into another evacuated receiver, and the reſt I ſtopped up cloſely with common air, that nothing might get out.

In four hours the aſcenſion of the mercury was four digits.

July 19. In fourteen hours the aſcenſion of the mercury was 1 ½; but ſuſpecting the air to have eſcaped, I ſet the ſcrew.

In nine hours the aſcenſion of the mercury was eleven digits.

The cover was broke, and the air made an eſcape.

THIS experiment ſeems to prove, that gooſberries contain much air in them, which, as ſoon as it is freed from the wonted preſſion of the air, doth more readily break forth, than when it is reſtrained by ſome ambient air, until the gooſberries begin to be fermented, for then air is produced in a far larger quantity, even in a great compreſſion.

EXPERIMENT IV.

I included paſte in an exhauſted receiver, and, before it was guarded againſt the external air, the mercury was come to the height of three digits, by reaſon of the air making an irruption from without; whence it came to paſs, that the paſte, which was much ſwollen, loſt about the third part of its tumidity.

A little while after it ſwelled again, and within half an hour the mercury mounted higher by two digits.

In one hour's time the aſcenſion of the mercury was 2 ½; and the paſte continued to ſwell or riſe more and more.

In another hour's ſpace the aſcenſion of the mecury was three digits and ½.

In one hour's time the aſcenſion of it was 4 ½ digits: it ſtaid in ſixteen.

July 9. In 14 hours ſpace, the aſcenſion of it was 21 digits. The height of the mercury was 37. Moreover I ſuſpected, that ſome air had got out. When I ſet the ſcrew, the cover brake, and upon the ingreſs of the external air, the paſte, which always did riſe, now did abate about two digits of its tumidity, though it was now found in a leſs compreſſion than before.

In five hours ſpace the aſcenſion of the mercury was 15 digits.

BUT when I again endeavoured to ſet the ſcrew, the cover brake, ſo that the air eſcaped; the paſte did preſently ſomewhat pitch, and was depreſſed.

In four hours ſpace the aſcenſion of the mercury was 10 digits: the paſte did again ſwell or riſe, as before; but being willing to ſubſtitute a better ſcrew in the place of the other, I permitted an egreſs to the air; yet this time the paſte did not pitch or ſubſide, as before it had done.

July 10. THIS night the paſte roſe again, yet it ſeemed to have produced no air.

In four hours ſpace there was no aſcenſion of the mercury.

In ſeven hours ſpace the aſcenſion of it was four digits.

July 12. I perceived no aſcent of the mercury.

13. It ſeemed to have aſcended a little.

17. Seeing no more air was produced, I took out the paſte, and found it to be of a ſubacid ſmell.

THIS experiment ſeems to prove, that air may be produced out of paſte, in compreſſed air, as well as *in vacuo*.

BUT the paſte was twice depreſſed, becauſe the compreſſed air ſuddenly finding out a way of eruption, was ſo much dilated, as it is wont to happen in all ſprings, when they are carried beyond their point of reſt: but when that air was immediately repelled by the external air, the paſte did pitch and was depreſſed.

EXPERIMENT V.

July 13, 1676. I included ſome beans, of that ſort, which are given to horſes for provender, *in vacuo*, with ſome water: ſome of them, which were bruiſed, ſeemed to ſwell much; but thoſe, which were left whole, ſuffered no ſenſible alteration.

In two hours ſpace I ſaw no air produced, though the beans continued to ſwell.

July 14. In 24 hours the aſcenſion of the mercury was ſeven digits.

July 15. In 16 hours the aſcenſion of the mercury was three digits and ½.

In eight hours the aſcenſion of it was 1 ½; the height of it was 12.

July 16. In 14 hours the aſcenſion of it was three.

17. In 26 hours the aſcenſion of it was ſix.

18. In 24 hours the aſcenſion of the mercury was almoſt nine.

19. I ſtopped the receiver firmly with a ſcrew, becauſe the air had got out. In nine hours ſpace the aſcenſion was one digit.

20. In 24 hours ſpace, the aſcenſion was 3 ½.

21. In 24 hours ſpace the aſcenſion was 5 ½.

22. In 14 hours the aſcenſion of the mercury was two digits.

23. In 24 hours the aſcenſion of the mercury was 18 digits.

24. In 14 hours the aſcenſion of the mercury was almoſt five. The height of it was 35 above the wonted preſſure.

25. The receiver could not ſuſtain a greater preſſure. I found the beans of a fœtid ſmell, not much unlike the ſmell of putrified fleſh.

FROM this experiment it ſeems to follow, that beans contain much air in them; and that that air is produced in a moderate preſſure, as well as *in vacuo*, ſometimes more ſpeedily, ſometimes more ſlowly.

ESPECIALLY, that great inequality, which happened *July* 23, is to be taken notice of.

EXPERIMENT VI.

July 23. I INCLUDED gooſberries *in vacuo*, and fortified them very well againſt the external air.

IN two hours ſpace the mercury aſcended one digit.

July 24. The height of the mercury was ſeven digits ½.

July 25.	The height of it was	12
26.		17
27.		20
28.		24 $\frac{1}{2}$

29. The height of it was almoſt 30.

30. The height of it was almoſt 31. I tranſmitted ſome air out of this receiver into another evacuated receiver, and ſo the height of the mercury was 26.

31. The height of the mercury was 35.

Auguſt 1. THE height of the mercury was 39. But ſome air had eſcaped out; and going about to ſtop the receiver cloſe, I ſuffered ſome more air to get out.

The height of the mercury was 30.

2. The height of the mercury was 39. I tranſmitted ſome air into another receiver.

The height of the mercury was 31

3. The height of the mercury was 39.

4. The height of the mercury was 41.

5. The height of the mercury was 43. I tranſmitted the air into another receiver.

The height of the mercury was 30 digits.

6. The height of the mercury was 43.

7. The height thereof was 47.

8. The height thereof was 48. But the air being tranſmitted into another receiver, the height of it was 36.

9. The height of the mercury was 41. Fourteen hours were paſt.

10. The height of the mercury was 47; the air being tranſmitted into another receiver, the height of it was 35: 24 hours were elapſed.

11. The height of the mercury was 38 $\frac{1}{2}$. Fourteen hours were elapſed.

12. The height of the mercury was 42; twenty four hours were paſſed. I extracted the air, and the height of the mercury was 26.

13. The height of the mercury was 33: twenty four hours were elapſed.

Aug. 14.	The height of it was	36	hours 24
15.		39	
16.		41 $\frac{1}{2}$	
17.		44	
18.		47	
19.		50	

I TRANSMITTED the air into another receiver, and the mercurial gage was ſpoiled. I took out the gooſberries, and found, that they had loſt their colour, and alſo almoſt all their acidity.

FROM this experiment we may infer, that gooſberries do produce their air regularly enough, unleſs ſomething be extracted out of the receiver; for then they acquire ſtrength to produce new air more ſpeedily.

EXPERIMENT VII.

Sept. 12. I PUT crude grapes into an emptied receiver; but before they could be fortified againſt the external air, ſome thereof had got in, as much as could ſuſtain three digits of mercury.

Sept. 13.	The height of it was	5
14.		10
16.		17
17.		19
19.		23
20.		25

Sept. 22. The height of the mercury was 30. I ſtopped the receiver with a ſcrew.

23. The height of the mercury was about 30 $\frac{1}{2}$.

24. The height thereof was 32.

Sept. 26.	The height of it was	34 $\frac{1}{2}$
27.		36 $\frac{3}{4}$
28.		36 $\frac{3}{4}$
29.		37 $\frac{1}{4}$
30.		37 $\frac{3}{4}$
Octob. 2.		39 $\frac{1}{2}$
4.		39 $\frac{3}{4}$
5.		40 $\frac{1}{2}$
7.		41 $\frac{1}{2}$
9.		42 $\frac{1}{2}$

Octob. 15. The height of the mercury was 46. It aſcended chiefly theſe two laſt days, when the froſt was diſſolved.

Nov. 2. The height of the mercury was 54 digits.

Nov. 5. The height was 58.

Jan. 10, 1677. NOW the mercury was come to the height of 70 digits; and yet I perceived no ſenſible mutation in the mercurial gage, even when the cold was moſt fierce, though the grapes and their juice were concreted into ice.

Sept. 21. HITHERTO the grapes ſeemed not altered: but the mercury had aſcended a little, becauſe the air had found a paſſage out. This day I opened the receiver, and when the air brake forth, many of the grains ſeemed to be contracted into wrinkles. The grapes had kept their taſte, but much more pungent; but their juice continued to be tinged with a curious red colour.

THIS experiment ſeems to inform us, that grapes produce not all their air, but in a long tract of time.

EXPERIMENT VIII.

Auguſt 10, 1677. I PUT pears, cut in two, into a vacuous receiver. Towards evening the mercury was come up to the height of 10 digits.

Aug. 11.	The height of it was	20
13.		38
14.		48
15.		55
16.		60
17.		68

The air being tranſmitted into another receiver, the height of the mercury remained at $53\frac{1}{2}$.

Aug. 18.	The height of it was	61
19.		64
20.		70
21.		72

The air being tranſmitted into another receiver, the mercury remained in the height of 61.

Aug. 22.	The height of it was	68
23.		74
24.		79
25.		81

The air being tranſmitted into another receiver, the height of the mercury was 61.

Auguſt 26. The height of the mercury was 56. becauſe ſome air had got out; yet I tranſmitted the air into another receiver, and the mercury remained in the height 52.

Aug. 27.	The height of it was	60
28.		68
29.		75
30.		83
31.		88
Sept. 1.		93

Sept. 2. The height of it was 100.

Sept. 3. The height of it was 89. becauſe ſome air had eſcaped out, which made me cautious to prevent the like for the future.

Sept. 4. The height of the mercury was 100.

5. The ſame height continued.

7. The ſame height ſtill continued, though no air at all had any egreſs.

9. The height of the mercury was 107.

10. The height of the mercury was the ſame.

The air being tranſmitted into another receiver, the mercury ſtaid in the height 99.

Sept. 11. The mercury moved not.

13. The height of the mercury was 105.

Octob. 8. I this day found, that the air had got out.

THIS experiment ſeems to inform us, that pears do produce their air, as it were, by paroxyſms, or fits.

ARTICLE XI.

Various experiments.

EXPERIMENT I.

March 16. I MELTED down lead with a fire in a braſs veſſel, whoſe diameter was an inch and half; but before the lead was concreted by cold, I put it into a receiver, out of which I exhauſted the air with great ſpeed; whence it came to paſs, that the figure of the concreted lead was concave, and the parts of it were ſo much the more depreſſed, by how much they were the nearer to the center: whereas, on the other ſide, lead congealed in common air doth exhibit a convex figure, except in the middle, where a little cavity doth appear.

I MADE the ſame experiment with tin, and had the ſame ſucceſs; though both metals being liquid, and very hot, had remained long enough *in vacuo*, yet no bubbles ſeemed to emerge from either of them; whereas all other hot liquors do ſend forth numerous bubbles *in vacuo*.

EXPERIMENT II.

Sept. 2. I PUT water ſaturated with diſſolved ſalt, *in vacuo*, to try, whether it would be there converted into chryſtals, and the ſalt be carried above the plain, or ſuperficies of the water, as it is wont to happen in the free air.

Sept. 15. THE water with the diſſolved ſalt abiding in the ſame ſtate, I opened the receiver: ſeeing no vapours could eſcape out of the evacuated receiver, it is conſentaneous to reaſon to judge, that the ſalt could not there be converted into chryſtals.

EXPERIMENT III.

Auguſt 8, 1676. I PUT air produced from gooſberries, into an evacuated recipient, furniſhed with a mercurial gage.

March 1, $167\frac{6}{7}$. WHEN I perceived, that no change was made in the height of the mercury, I opened the receiver.

EXPERIMENT IV.

Auguſt 8. I TOOK a phial, which was able to hold ſeven ounces five drachms and three grains of water, and exhauſted the air out of it; and when, in a balance, it was ſuſpended in an *æquilibrium* with another weight, I pierced the bladder, which covered the orifice, with a needle; and then the phial, being filled with air, appeared heavier by four grains and $\frac{1}{2}$, which latter weight to the former, is in the ſame proportion as 1 to 814: whence it follows, that water is about 800 times more ponderous than that air of an equal bulk. Yea, it is probable, that the proportion is with the leaſt, becauſe this day the air was hot and clear, and beſides, ſome air was always left in the receivers after the exhauſtion.

EXPERIMENT V.

Jan. 16, 1677. I PUT *aqua fortis* with fixed nitre into a receiver; and having exhauſted the air as much as I could, I poured in one of them on the other, and found much air produced. I marked the height of the mercury in the gage.

March 5. FINDING, that the produced air was not deſtroyed, and that the mercury perſiſted in the ſame height, I opened the receiver, and found nitre produced *in vacuo* from the mixture.

EXPERIMENT VI.

May 12, 1677. I FILLED a phial, of a long and very narrow neck, with oil up to the middle of the neck; and thus filled, I put it into a receiver firmly ſtopped by the help of a ſcrew, into which afterwards I intruded air till it could ſuſtain 120 digits of mercury above its wonted height; and the oil, in the neck of the phial, appeared depreſſed toward the phial about one quarter of an inch; the cauſe whereof I judge attributable to the compreſſion of the air: and yet having eaſed the ſcrew, and thereby ſuffered the air to break in and be dilated, the oil did not aſcend at all; ſo that I judge it was condenſed only by cold.

Auguſt 5. I MADE the ſame experiment after the ſame manner, only uſing water inſtead of oil; and yet I could perceive no change of the height of the water in the neck of the glaſs, though the heat being moderate might have produced a ſenſible effect.

Jan. 14, 1678. BECAUSE I found by ſome experiments, that compreſſed air did enter into the pores of the water, and did pierce even to the bottom, a ſuſpicion might ariſe, that the water was not condenſed by the compreſſed air, for this reaſon, becauſe the air entering into the pores did make the preſſion within equal to the preſſion from without. And to be ſure of this, I filled the glaſs abovesaid with ſpirit of wine, leaving only the length of three digits in the top of the neck thereof, which was filled with air only. Then my hands being applied to the glaſs, the ſpirit of wine, being heated, in a ſhort time filled the whole neck even to the top. Then the glaſs being inverted into a veſſel full of mercury, I removed my hands; which being done, the ſpirit of wine being ſoon cooled, afforded ſpace to the mercury to fill three digits in height. I put the veſſel and the glaſs in that poſture into a receiver, into which I afterwards compreſſed the air, till the mercury exceeded its wonted height 90 digits; and yet there was no ſenſible condenſation of the ſpirit of wine, nor any aſcenſion of the mercury: however, it is certain, that no air had crept in, becauſe the mercury hindered it; and the receiver being opened, when the air, that compreſſed from without, was dilated, no bubbles appeared in the ſpirit of wine.

IN this experiment, it ſeems worthy our enquiry, how it comes to paſs, that ſpirit of wine was ſo ſenſibly condenſed by a moderate cold, and not at all by a great compreſſion of the air.

EXPERIMENT VII.

May 12, 1676. I POURED ſpirit of wine into a glaſs veſſel, and ſuperadded ſome drops of oil of turpentine thereto, which ſwimming upon the ſpirit of wine, began to be whirled about by motion, hither and thither, as it is wont to come to paſs. I put the glaſs veſſel on the pneumatic engine, and covered it with a receiver; and yet the bubbles did not at all ceaſe to be moved up and down. Then I pumped out the air, till the ſpirit of wine did only not bubble; and it came to paſs, that the bubbles emerging from the ſpirit of wine did adhere to the drops of oil, and carried them with themſelves to the ſides of the veſſel, and there retained them; yet two drops, free from ſuch bubbles, proceeded to have further motion: afterwards I wholly exhauſted the receiver, and ſome drops were emitted to the top thereof, by the force of the bullient ſpirit of wine; but the remaining drops proceeded on to be moved a little, and in a little time after they reſted. The air being immitted, the drops began again to renew their motion, but it was a ſlow one, and it quickly ceaſed.

I ITERATED the ſame experiment with ſpirit of wine and oil of turpentine, cleanſed from air; and no ebullition was then made, yea, no bubble appeared at all, but the drops of the oil of turpentine were moved *in vacuo*, as in the open air.

HENCE it ſeems to follow, that the cauſe of the motion of the drops is not to be aſcribed to the diſſolution; for all the diſſolutions *in vacuo* have hitherto ſeemed to me to produce bubbles.

EXPERIMENT VIII.

May 19, 1676. I LEFT yeſterday two radiſhes *in vacuo*; one of them I hanged up, the root being upſide down, the other in a contrary poſture; both of them cut tranſverſly did hang over a ſubjacent veſſel, which contained red wine. All theſe being left a whole night *in vacuo* ſeemed well purged from their air. Opening the receiver, I added two other radiſhes to the former included ones, cut after the ſame manner, and from which I had further detracted their thick ſkin. Then exhauſting the receiver, I immerged the cut part of all the radiſhes at once into the ſubjacent wine: and then many bubbles ſeemed to ariſe out from them, as it came to paſs in thoſe little glaſs-tubes of *Exper.* IX. yea, more bubbles were emitted from thoſe radiſhes, which were purged from air the whole night, than from thoſe, which had not remained above half an hour *in vacuo*; and from whom I had taken away their ſkin.

THIS experiment ſeems to afford us a confirmation, that bubbles are formed of particles of air ſwimming in water; and becauſe in the ſkin there are ſome canals fit to retain parts of air, it came to paſs, that the radiſhes, from which I had detracted their ſkin, afforded no opportunity for the forming of ſo many bubbles.

THE liquor aſcended no leſs into thoſe radiſhes, which hanged with their roots upwards, than into thoſe of a contrary poſture.

EXPERIMENT IX.

May 4, 1677. I IMMERGED one end of a ſmall glaſs-tube, open at both ends, into water ſtagnant *in vacuo*, and preſently the water aſcended up into it, as it is wont to do in common air, and even to the ſame height; but a little while after, many bubbles being formed there, lifted the water higher, and kept it ſuſpended in three different places, diſterminated by many bubbles; and many other bubbles ſeemed to paſs out from that end, which was immerſed in water.

THEN I ſealed the other end of the tube hermetically; and ſo the experiment being made in common air, the water could not aſcend up into the tube by the open end. But *in vacuo* the matter ſucceeded far otherwiſe; for the water aſcended up into the tube no otherwiſe, than if it had been open at both ends; and many bubbles formed in a ſhort time, did diſtinguiſh the water, contained in the tube, by great intervals, as before; whilſt the mean time, many other bubbles ſeemed inceſſantly to paſs out from the end of the tube immerſed in water; yet in progreſs of time they appeared leſs frequent.

BUT this circumſtance I much admired, that the water being ſuſpended higher in the tube, ſeemed to be filled with no bubbles, whereas the end only did emit ſo many.

THEN I took out that end from the water, and no bubbles did any more appear, though that end was wholly filled with a cylinder of water.

May 5. I REPEATED the ſame experiment; but before I had immerged the end of the tube in water, a drop of water, which ran over from the ſuperior aperture of the receiver, flowed down to the open end of the tube, and pierced up into it the height of two lines; neither was any bubble formed there in a full half hour's time: that being paſſed, I immitted the end of the tube into the water of the veſſel, and not long after bubbles began to be formed, as before, of which ſome followed others within half a minute; yet afterwards they came forth leſs frequent. Furthermore, iterating this experiment many times, I perceived, that when the water was extracted from the tube, no bubbles appeared; but if it were immerged in water, bubbles would cleave to the end of it, either ſooner or later.

May 6. I TRIED the ſame experiment, with the infuſion of nephritic-wood, and the ſucceſs was wholly alike, but that the bubbles could emerge and pierce the liquor, before they had acquired any bigneſs; for being yet very ſmall, they pervaded the liquor contained in the tube, and were carried to the upper part thereof: whence we may conjecture, that that liquor is very thin, and hath no viſcoſity to reſiſt the pervading body.

May 10. I ITERATED the ſame experiment with ſpirit of wine, mixed with a certain oil made *per deliquium*: yet I found no new event, but that the aſcenſion of the liquor into the tube was not ſo high.

FROM theſe experiments it ſeems to follow, that the bubbles are formed, in the extremity of the tube, of aerial particles, ſwimming in the water, which finding ſome impediment at that end cannot paſs by, and ſo, new ones coming upon them, they ſwell into a bubble.

EXPERIMENT X.

July 18, 1676. TWO days ago I took ſome beans, ſuch as are given to horſes for provender, and included them in an iron tube cloſely ſtopped; yet I firſt affuſed water on the compreſſed beans, till the tube ſeemed wholly full, to try, whether the force of the ſwelling beans would be enough to break the tube. This day the tube ſeemed not to be altered at all; but the ſtopple being plucked back, ſome quantity of air brake out, and much water fell upon the ground, which was not ſucked up by the beans; then a certain noiſe, as it were, of bubbling water was heard for a whole hour and more.

July 25. I LEFT the iron tube in the ſame poſture; but this day one of the ends of it being unſtopped, and ſome beans taken out, the murmur of the bullient water was heard, as before.

FROM this experiment it ſeems to follow, that beans do contain air in them, which in a great compreſſion cannot eſcape out; but if it be freed from the force compreſſing it, then it makes an eruption.

EXPERIMENT XI.

March 4, 1677. I PUT a glaſs half full of ſpirit of ſal-armoniac and *limatura cupri*, into a receiver exhauſted as much as I could, and there ſtopped it in. And it came to paſs, that in 15 minutes ſpace the liquor had contracted a certain blue colour, but very much diluted; but the air being immitted, in three minutes the blue colour appeared vivid and thick. I put the liquor ſo tinged again *in vacuo*, to try, whether in tract of time that colour would vaniſh.

April 4. THE blue colour was almoſt quite vaniſhed, but upon the admiſſion of the air, it quickly returned.

EXPERIMENT XII.

May 8. I PUT a certain oil made *per deliquium*, with ſpirit of wine into an exhauſted receiver, and the ſpirit always ſwam on the top; now leſt the ſpirit might be ſpilt by bubbling above the edges of the veſſel, I extracted the air by degrees, and in the beginning great bubbles came from the ſpirit, and but very ſmall ones from the oil; but after one hour's time, the oil did emit great bubbles, which, being ſmall at bottom, in their aſcent did fill the whole latitude of their veſſel; and after another hour, ſome bubbles brake out with ſo great force, that they hit againſt the top of the receiver.

May 9. I ITERATED the former experiment in a glaſs ſomewhat long and narrow, that I might the better perceive the motion of the bubbles; and then I ſaw the bubbles paſſing out of the oil into the ſpirit of wine, without any great increaſe of their quantity; but being diſtant only one quarter of an inch from the ſuperficies, they were ſuddenly expanded.

EXPERIMENT XIII.

May 3, 1676. I MIXED a certain quantity of *Aqua Fortis* with a quantity of ſpirit of wine ſomewhat greater; and then I diſtributed that mixture equally into three glaſs veſſels, and put three equal pieces of iron into them, to each veſſel one. This being done, I included one of the three veſſels *in vacuo*, and there many great ebullitions were made. Then after a quarter of an hour, I took out the veſſel, and found the liquor black and turbid; whereas the other two veſſels had their liquor not altered in colour, but only ſome black powder did appear in the bottom of the liquor.

OF theſe two veſſels I put one *in vacuo*, and then there aroſe ebullitions, great indeed, but much leſſer than the former: when one quarter of an hour was elapſed, I took the veſſel *è vacuo*, and found the liquor black indeed, yet ſomewhat leſs ſo than the former; but the liquor, which was left always in the air, did in a manner remain unchanged.

May 4. THIS day in the morning, the liquors in the two veſſels, put *in vacuo*, appeared cleanſed and green, and had no other operation.

BUT the liquor, which was not put *in vacuo*, did bubble more ſtrongly than yeſterday, and exhibited a red colour. I put the three veſſels together *in vacuo*, and perceived no eminent ebullition; only ſome bubbles appeared larger in the red liquor, than in the other two.

FROM this experiment, it ſeems to follow, that ſpirit of wine *in vacuo* doth accelerate ebullition.

EXPERIMENT XIV.

Jan. 21, 1678. I KEPT a glaſs half full of ſal armoniac and filings of copper, the hole thereof being ſo exactly ſtopped, that the blue colour, which was induced into that liquor, from the contact of the external air, (ſee *Philoſophical Tranſactions, Num.* 120.) did wholly now diſappear. The ſtopple was made of leather, prepared after a ſpecial way and manner.

I PUT that glaſs *in vacuo* with paſte not yet fermented.

I DID it to this end, that the receiver, being full of air from the paſte, I might perforate the leather, that ſtopped the glaſs, with an iron wire prepared for that purpoſe; and that I might try, whether the contact of the air generated from the paſte, would alſo communicate ſome colour unto the liquor.

Jan. 22. THERE was no need to perforate the leather, for this day I found the liquor already tinged; ſo that it is probable, that air produced from paſte is endued with ſuch minute particles, that it can penetrate leather, which is impervious to common air.

YET I will keep the glaſs, not touching its ligature, to try, whether that colour may vaniſh again.

Jan. 25. NOW the liquor became almoſt colourleſs; whence it appears, that common air is too thick to penetrate all paſſages, which are pervious to air produced from paſte.

Feb. 2. I PUT the ſame phial *in vacuo*, but did not fortify the commiſſure of the receiver with the cover, with turpentine; ſo that the air, making a gradual ingreſs, in 24 hours filled the receiver, even as it was leiſurably filled with the air produced from paſte; yet the liquor remained ſtill colourleſs.

Febr. 15. I PUT the ſame glaſs again *in vacuo* with ſome quantity of paſte; but this time the air produced from thence did not pervade the leather, as it had done before, and the liquor was not tinged at all.

EXPERIMENT XV.

April 2, 1678. I PUT a ſhrew-mouſe into the engine deſcribed, *p.* 104. and when I perceived he was reduced to extremity, I began to ſtir the pump, that the air might penetrate, and be, as it were, filtrated through the water. The mouſe, a while after, ſeemed to be better, yet he could not be wholly reſtored to health. Now, becauſe he had been long kept faſting, I am uncertain, whether he died for want of aliment, or of new air.

April 12. I ITERATED the ſame experiment with a ſmall and weakly mouſe, that had been kept a long time faſting. And finding, that this experiment had the ſame ſucceſs with the former, I took out the mouſe before he was dead; and though he then enjoyed the free air, yet he recovered not; ſo that we have need of more experiments, that we may attain to a certain knowledge of the effect of that filtration.

EXPERIMENT XVI.

May 2, 1678. SIX weeks ago, I included frog-ſpawn in three recipients; the firſt of which was vacuous; the ſecond contained common air; and into the third I intruded ſo much air, that the mercury ſtaid in 60 digits above its wonted height.

IN 15 days the mercury in the evacuated receiver came to the height of one digit. The ſpawn in the common air ſeemed corrupted and of a blackiſh colour; but that in the compreſſed air remained unaltered in colour; but no frogs were generated.

AFTER an whole month was elapſed, the ſperm *in vacuo* had not changed its colour, excepting the black round ſpots, but ſeemed reduced into water; the colour of that in the common air was very black; but in the compreſſed air the ſpawn began to be reddiſh.

As yet no change was perceived, neither in that ſpawn *in vacuo*, nor that in the common air; but in the compreſſed air the ſpawn waxed more and more red.

May 22. The ſperm *in vacuo* was not changed; in the compreſſed air it remained red; but in the common air it became again colourleſs.

June 23. The ſperm *in vacuo* and in common air was tinged with no colour, but in the compreſſed air it inclined to greenneſs.

Octob. 15. I took out all the ſpawns; that which was kept *in vacuo* was almoſt exhaled out of its veſſel, and was ſtagnant in the receiver, like clear water: in the common air, the ſperm remained colourleſs; but that in the compreſſed air kept ſtill its red colour.

EXPERIMENT XVII.

May 9, 1678. Six days ago, I included two pieces of the ſame orange in two receivers, not quite of equal bigneſs; but in the greater receiver there was left ſome quantity of water, ſo that no leſs ſpace was left for the air in that, than in the leſſer. The iſſue was, that the orange included with water, though it were not touched by it, yet was four times more mouldy than that, which was kept without water.

And therefore in iterating this experiment, I put two pieces of the ſame orange into two receivers, but I filled the third part of one of them with water, yet ſo, that it did not reach the orange.

June 15. Neither of the oranges had contracted any mouldineſs.

May 16. I repeated the ſame experiment with the ſame ſucceſs; yet neither orange had acquired any mouldineſs in the ſpace of more than a month, though in former experiments all ſuch oranges would be mouldy.

The cauſe of the difference ſeems to be attributable to ſome diſpoſition of the air.

EXPERIMENT XVIII.

June 1, 1678. I put a ſmall glaſs-tube, half full of Venice turpentine, into the wind-gun, deſcribed *p.* 104. and I had ſcarce reduced the air to the tenth part of its wonted ſpace, but the leather, ſpread over the elliptic valve, was driven out; ſo that the air having made an eſcape, I drew the glaſs-tube out of the engine, and found many bubbles formed in the ſuperficies of the turpentine; and therefore I ſuſpected, that the air had pervaded the turpentine, and that it would have penetrated more deeply into it, if they had remained longer thus encloſed together: and therefore I re-immitted the ſame tube into the ſame gun, and there left it in air reduced to about the 15th part of its ſpace.

June 3. I opened the engine, and, taking out the tube, found the turpentine almoſt free from bubbles; yet by degrees many were formed therein, in the parts remote enough from the ſuperficies.

June 4. I threw away the former turpentine, and put new in the ſame tube, and included it *in vacuo*, that the turpentine might be the better purged from all air; then I poured water upon it, and ſhut up all in the wind-gun.

June 8. I opened the engine, and at firſt ſight both the water and the turpentine in the tube ſeemed to be very free from bubbles; but a little while after I perceived, that bubbles were formed in the turpentine, and that they aſcended by degrees; yea, ſome of them ſeemed to be made almoſt in the very bottom, about half an inch below the ſuperficies of the turpentine. So that we may conjecture, that all the water, and ſo great an height of the turpentine, were penetrated by the air, which formed thoſe bubbles.

EXPERIMENT XIX.

Aug. 11, 1678. I included ſpirit of ſal armoniack, with a mercurial gage, *in vacuo*; and after that the ſpirit ceaſed to emit any bubbles, I mixed filings of copper therewith, which cauſed many bubbles to break forth again; but they were ſo far from producing any air, that they contrariwiſe conſumed that, which was there before; as it hath been already obſerved in the *Philoſophical Tranſactions*, N. 120: but the liquor was made greeniſh and turbid.

Dec. 5. The ſpirit was almoſt all exhaled out of the veſſel, in which it was contained, and being condenſed in the receiver, remained ſtill turbid, by reaſon of much filth, which was included there; but that, which was not exhaled out of the veſſel, appeared clear like water: alſo the mercury was wholly expelled out of the gage. Whence I conjecture, that the air in the receiver was more and more conſumed.

EXPERIMENT XX.

Sept. 2, 1678. I put two cylinders, one of tin, the other of lead, *in vacuo*, but their loweſt parts were immerſed in mercury; and at the ſame time I immerſed two other cylinders, like the former, after the ſame manner in mercury: but theſe latter were left in the free air.

Sept. 6. I opened the vacuous receiver, and the mercury, in the tin cylinder, was come to the height of four digits and a half above the ſuperficies of the ſtagnant mercury; and cutting the cylinder tranſverſly in the middle of that height, the amalgama ſeemed to have penetrated into the cylinder about half a line. And cutting the cylinder tranſverſly again, in that part, which was diſtant only one digit from the ſuperficies of the ſtagnant mercury, I found the thickneſs of the amalgama to equal one line.

In the lead cylinder the mercury came to the height of two digits and ½, but only as far as the ſuperficies; and that very part, which was immerſed in the mercury, was not penetrated by it to any ſenſible thickneſs.

Sept. 7. I TOOK out the tin, left in the air, out of the mercury, in which it was immerged, and found the mercury to have aſcended to the height of five digits.

Sept. 10. THE ſame cylinder being left in the mercury, ſeemed to be beſmeared therewith up to the very top, ſix digits and more above the ſuperficies of the ſtagnant mercury. When the cylinder was tranſverſly cut in ſeveral places, it appeared, that the mercury had pierced ſo much the higher into the tin, by how much it came nearer to the ſtagnant mercury; ſo that in the part near to the foreſaid mercury, almoſt the whole diameter of the cylinder, three lines broad, was penetrated thereby.

IN the lead cylinder the mercury exceeded not the height of three digits and ½, neither had it penetrated to any ſenſible thickneſs. Whence it appears, that the weight of the air contributes little or nothing to the aſcenſion of mercury into metals.

EXPERIMENT XXI.

Dec. 12, 1678. I TOOK a ſmall whiting, and having cut off his head, I divided him tranſverſly into five pieces. The firſt whereof I included *in vacuo*. The ſecond in common air. The third in air ſo compreſſed, that it could ſuſtain mercury 50 digits above its wonted height. Theſe three receivers were cloſed with ſcrews. The fourth piece was put into a receiver, full of air produced from paſte, which was preſently ſtopped. The fifth was left in the free air.

Dec. 15. THIS day in the morning, that part of the whiting, which was left in the free air, began to ſhine; and towards evening it ſent forth ſomewhat a more vivid light.

Dec. 16. IN the morning, the whiting left in the free air, gave over ſhining; but towards evening it ſhone again.

Dec. 17. THIS morning the ſame part of the whiting ſhined a little, yet leſs than it did yeſterday in the evening.

Dec. 18. IN the morning there appeared no light, though I fixed my eyes a long time upon the receiver in a dark place; but the night coming on, the light appeared again.

Dec. 20. HITHERTO the ſame part of the whiting, left in the air, proceeded to ſhine; but all the other parts did not yet begin to ſhine.

Dec. 22. YESTERDAY the light of the whiting, left in the air, had not quite ceaſed; but this day it appeared no more.

Dec. 24. THE part of the whiting in the free air gave over its ſhining quite; but that, which was included with common air, did yeſterday ſend forth a faint light; but this day it proceeded not to ſhine.

Dec. 26. No ſhining appeared any more in the common air: but the three other pieces did not ſo much as begin to ſhine.

Jan. 26, 1679. I PERCEIVED no more ſhining in any one of the receivers.

ARTICLE XII.

Artificial air deſtroyed.

EXPERIMENT I.

Aug. 3, 1677. I TRANSMITTED air, produced from cherries, into a receiver full of common air, but ſo ſtopped with a ſcrew, that the mercury aſcended to 25 digits above its wonted preſſure.

Aug. 4. THE mercury was depreſſed about two digits. The height of it this day was only 23 digits.

Aug. 6. The height thereof was reduced to 20 digits.

7. The height thereof was the ſame.

8. The mercury was ſomewhat depreſſed.

Aug. 10. THE height of it was 19 ½ above its wonted height. When I perceived little or no alteration more, I opened the receiver.

FROM this experiment we have a confirmation, that air, produced from fruits at the beginning, is in part deſtroyed; but the reſt can keep the form of air very long.

EXPERIMENT II.

May 26, 1676. I TOOK ſix grains of ſal armoniack, and put them into a receiver with a ſufficient quantity of oil of vitriol: then the air being exhauſted, I forced down the ſalt into the oil, whereupon a great ebullition preſently followed, and the mercury aſcended into the gage almoſt to its wonted height; but preſently after it ſunk again, and returned to its former ſtate.

May 27. I REPEATED the ſame experiment; but this time the ſalt remained 10 hours *in vacuo* before it was put into the oil, but the ebullition followed as in the former experiment; yet the air was produced much more ſlowly, neither could it wholly be deſtroyed but in ſeven or eight hours time; yet at laſt the mercury deſcended to the very bottom.

May 29. I TRIED the ſame experiment again, leaving the materials 24 hours *in vacuo*: this time the ebullition ſeemed much leſs, and the air was produced both in a leſſer quantity and more ſlowly than before. I obſerved alſo, that whilſt the materials ſtaid *in vacuo* before their mixture, that the mercury came nearer to the open end of the gage, as if ſome air had been either extracted or deſtroyed.

June 8. I PUT oil of vitriol alone into a receiver, in which I left only a fifth part of common air, to try, whether this oil, without ſal armoniack, would diminiſh the elaſtical force of the air: but it fell out contrary, that the force of the air was increaſed, and the mercury, in one hour's ſpace, ſeemed to have aſcended a little into the gage; but afterwards, for 24 hours ſpace, no change was made.

THIS experiment doth confirm, that ſome artificial airs may be deſtroyed; but why this deſtruction happens ſometimes ſooner, ſometimes ſlower, it may perhaps ſeem worthy of a further enquiry.

ARTICLE XIII.

Experiments concerning the different celerity of air produced in vacuo, *or in common air.*

EXPERIMENT I.

Common air.

July 10, 1676. I PUT paſte, kneaded two days before and ſouriſh, into a receiver, and ſtopped it firmly with a ſcrew.

IN one hour's ſpace the height of the mercury was one digit.

IN ſeven hours ſpace the height of it was ſix digits.

July 11. The height of it was 11 digits.
12. The height of the mercury was 24.
13. The height thereof was 30.
14. The height of the mercury was ſenſibly greater.
15. The mercury aſcended a little. Meaſuring its height exactly this day, I found it 38 digits.
19. No more air was produced from the paſte.

Vacuum.

July 10, 1676. I PUT another quantity of the ſame paſte, much leſs than the former, into an exhauſted receiver.

THOUGH the quantity of the paſte was leſs, yet in one hour's time the height of the mercury was two digits.

IN ſeven hours time the mercury came almoſt to the top of the gage, but it was a ſhort one.

July 19. THE paſte was not able to remove the receiver from his cover, though at the beginning it had produced a greater quantity of air than the paſte in common air. I endeavoured to fire it with a burning glaſs, and the fumes, elevated therefrom, afterward falling upon the paſte, did tinge the ſuperficies thereof with a pleaſant yellow colour; and that air was thus produced, I conjectured hereby, becauſe the cover was afterwards eaſily ſevered from its receiver.

FROM this experiment, made in two receivers at once, we learn, that air is ſometimes generated much more eaſily *in vacuo* than in common air.

EXPERIMENT II.

Common air.

Aug. 20, 1676. I PUT paſte, kept for 24 hours, into a receiver full of common air; to which I further added new air; ſo that the mercury exceeded its wonted height four digits and $\frac{1}{2}$.

IN ſix hours ſpace the mercury gained almoſt four digits. Its height was eight digits.

Aug. 21. The aſcenſion of the mercury was four digits and $\frac{2}{3}$.
22. The aſcent of it was about one digit.
23. The aſcent of it was $\frac{1}{2}$ a digit.
26. For three whole days the aſcent of the mercury was only $\frac{1}{2}$ a digit.
27. There was no aſcent of it at all.
29. The paſte, taken out of the receiver, affected our noſtrils with an acid ſmell.

Vacuum.

Aug. 20. I PUT another quantity of the ſame paſte into an empty receiver, and kept the ſame proportion between the quantity of the paſte and the capacity of the veſſel, as in the former experiment.

THE mercury ſeemed to have aſcended in a ſhort time. Its height was two digits.

Aug. 21. The aſcent of the mercury was five digits.
22. The aſcent of it was three digits.
23. The aſcent of the mercury was one digit.
26. For three whole days the aſcent of it was two digits.
27. There was no aſcent of the mercury.
29. I took out the paſte, exhauſted of its air, from the receiver.

THIS experiment confirms to us, that air is ſometimes more eaſily produced *in vacuo* than in common air.

EXPERIMENT III.

Vacuum.

Sept. 4. 1677. I PUT the kernels of filberds into an exhauſted receiver.

Sept. 5. The height of the mercury was five digits.

6.	The height of it was	10
7.		10
8.		12
9.		15
11.		18
12.		23
13.		27
14.		29

15. The height of it was almoſt the ſame.
17. The height of it was 30.
18. This day the air began to eſcape out

out of the receiver; for ſome bubbles appeared in the turpentine, which ſtrengthened the commiſſure of the receiver and cover.

Common air.

Sept. 4. I PUT kernels of filberds into a receiver with common air.

In the afternoon the quantity of air ſeemed to be leſſened.

Sept. 5. The height of the mercury was leſs than half a digit.

6. The height of it was the ſame.

7. The height of it was one digit.

8. The ſame height ſtill continued.

18. The ſame height continued.

THIS experiment gives us a confirmation, that ſometimes air is produced much more eaſily *in vacuo* than in common air.

EXPERIMENT IV.

Sept. 15, 1677. I INCLUDED eight ounces of raiſins of the ſun, bruiſed and diluted with a little water, in an exhauſted receiver able to hold 22 ounces of water.

Sept. 16. The height of the mercury was ſix digits.

17.	The height of it was	10
18.		15
19.		29
20.		29

Sept. 21. THIS day I found the receiver forced from his cover.

Sept. 24. I TOOK out ſome of the raiſins; but thoſe, that remained, I encloſed in the ſame evacuated receiver.

Sept. 25. THE raiſins forced the receiver, now full of air, from his cover.

Sept. 15, 1677. I PUT eight ounces of raiſins of the ſun, bruiſed and diluted with a little water, into a receiver able to hold 22 ounces of water; but I did not exhauſt the air at all.

Sept. 16. The height of the mercury was ¾ of a digit above what was accuſtomed.

Sept. 17. The height of the mercury was 1¼.

18. The height of it was 3.

19.	The height of it was	5
20.		7
21.		9
22.		11
23.		12
24.		15

BEING about to put peaches into the receiver, I permitted the air to break forth; and then many bubbles did emerge from the raiſins.

THIS experiment doth further teach, that air is ſometimes much more eaſily produced *in vacuo* than in common air.

EXPERIMENT V.

Vacuum.

Feb. 17, 1677. I PUT three onions into an emptied receiver.

Feb. 19. The aſcenſion of the mercury was one digit.

21. The aſcent thereof was again one digit. The onions were not altered.

25. The whole aſcent of the mercury was nine digits. The onions not altered.

May 4. The onions had yet undergone no alteration.

18. Neither were they yet altered.

June 19. I THIS day found the receiver forced from his cover, and the onions rotten.

Rarefied air.

Feb. 17. I INCLOSED three onions in air ſo rarefied, that it could ſuſtain only 10 digits of mercury.

Feb. 19. There was no aſcent of the mercury.

21. There was yet no aſcent thereof. The onions did not germinate, but contracted a mouldineſs.

25. The aſcenſion of the mercury was about ſeven digits. The onions received no further alteration.

May 4. The onions were not altered.

18. The onions were not yet altered, but the receiver, by the force of the produced air, was removed from his cover.

Common air.

Feb. 17. I PUT three onions in a receiver not exactly ſhut.

Feb. 21. The onions contracted no mouldineſs, but did germinate.

25. The onions put forth root more and more.

May 4. The onions began to be mouldy.

THIS experiment gives us a likely proof, that ſome bodies do produce their air not much more eaſily *in vacuo* than in rarefied air.

AND beſides it hereby appeareth, that vegetation is hindered, not only by the evacuation, but alſo by the rarefaction of the air.

IT ſeems alſo worthy our obſervation, that the onions, as long as they emitted roots, did contract no mouldineſs.

ARTICLE XIV.

The difference betwixt whole or entire, and bruiſed fruits.

EXPERIMENT I.

Bruiſed fruits.

Aug. 23, 1677. I PUT pears bruiſed into a vacuous receiver with a mercurial gage.

Aug. 25. The height of the mercury was five digits.

Aug. 26.	The height of it was	10
27.		14
28.		18
29.		21
30.		25
31.		28

Sept. 1. The height of it was 30.

2. The receiver was found forced from his cover.

Whole or entire fruits.

Aug. 23. I PUT whole pears into a vacuous receiver, and I took care, that the quantity of the pears, and the capacity of the receiver, might be the ſame with thoſe, which I mentioned before.

Aug. 25. The height of the mercury was 11.

26.	The height of it was	17
27.		25
28.		28
29.		30

Aug. 30. THE mercury aſcended no higher, becauſe the receiver was forced from his cover.

THIS experiment ſeems to prove, that bruiſed fruits do not produce air as ſoon as entire ones.

EXPERIMENT II.

Entire fruits.

Aug. 24. I ENCLOSED whole apples *in vacuo* with a mercurial gage.

Aug. 25. The height of the mercury was five digits.

26.	The height of it was	9
27.		12
28.		15
29.		19
30.		25
31.		28

Sept. 1. The height of it was 29.

2. The height of it was 30.

3. The receiver was forced from his cover.

Bruiſed fruits.

Aug. 24. I PUT an equal quantity of bruiſed apples into a vacuated receiver of the ſame capacity with the former.

Aug. 25. The height of the mercury was one digit.

26. The height of it was three digits.

27. The height of it was four.

Sept. 3. The mercury continued in the ſame height.

25. The mercury aſcended not at all.

THIS experiment ſeems to inform us, that bruiſed fruit do produce air ſlower than whole or entire ones.

EXPERIMENT III.

Bruiſed fruits.

Aug. 25, 1677. I PUT unripe grapes bruiſed into a vacuated recipient,

Aug. 26. The height of the mercury was one digit.

27. The height of it was two digits.

28. The height of it was two digits and an half.

29. The height of the mercury was the ſame.

Sept. 15. The mercury did not aſcend at all, but its height remained at 2 ½.

Whole fruits.

Aug. 25, 1677. I PUT unripe grapes, not bruiſed, into a vacuated receiver.

Aug. 26. The height of the mercury was three digits.

27. The height of the mercury was five digits.

28.	The height of it was	7
29.		10
30.		12
31.		13

Sept. 1. The height of the mercury was 15.

2. The height of it was 16.

3. The height of it was 18.

4. The height of it was the ſame.

Sept. 5. The height of the mercury continued the ſame; but all the grapes had almoſt contracted a yellow colour.

Sept. 7. The mercury reſted in the ſame height; but all the grapes were yellow.

Sept. 15. The height of the mercury was 20.

THIS experiment gives us a further confirmation, that whole fruits do produce air more readily than bruiſed ones.

EXPERIMENT IV.

Fruits whole and entire.

Sept. 10, 1677. I PUT two ounces of ripe grapes, but not bruiſed, into a receiver able to hold 10 ounces of water.

Sept. 11. The height of the mercury was ſix digits.

12.	The height of it was	9
13.		12
14.		15
15.		20
16.		25
17.		28

18. The height of the mercury was 30. The grapes were not altered at all.

19. The height of the mercury was the ſame.

20. The receiver was not yet forced from his cover. The grapes were not altered, but appeared only a little riper.

21. The receiver was forced from his cover, though as yet nothing had made any eruption out.

22. This day in the morning I found the grapes begin to rot, and therefore I included them again *in vacuo*.

Sept. 23. The height of the mercury was five digits.

24.	The height of it was	9
25.		14
26.		17
27.		20
29.		27
30.		28

Octob. 10. The receiver was not forced from his cover till this day: the grapes by their colour ſeemed rotten, yet they had kept their firmneſs.

Bruiſed fruits.

Sept. 10, 1677. I INCLUDED two ounces of ripe and bruiſed grapes in a receiver capable of holding 10 ounces of water.

Sept. 11.	The height of it was	4
12.		7
13.		10
14.		12
15.		15
16.		18
17.		20
18.		25

Sept. 19. THE grapes had ſevered the receiver from his cover, and much juice was ſpilt.

Sept. 20. I AGAIN put the ſame grapes into the ſame receiver; but becauſe they had ſpilt their juice by ebullition, I did not exhauſt all the air; but the mercury ſtaid in the height of five digits.

Sept. 21. THIS day in the morning, the receiver, being now full of air, did no longer ſtick to his cover; ſo that I took out the grapes, and tranſmitted them into another receiver, which I ſtopped cloſe with a ſcrew, but extracted no air from it.

Sept. 22. The height of the mercury was 11 digits, though the receiver was able to hold 26 ounces of water.

Sept. 23. The height of the mercury was 19.

24. The height of it was the ſame.

30. The height of it was 20.

Octob. 3. WHEN the grapes produced no more air, I took them out, and found them of a bitter taſte, becauſe they were not yet come to their perfect ripeneſs.

THIS experiment, if you compare it with that, which I related before concerning unripe grapes, doth ſeem to intimate, that unripe grapes do produce leſs air when they are bruiſed, than when unbruiſed; but ripe grapes do the contrary.

EXPERIMENT V.

Nov. 19, 1678. I PUT apples into three vacuated receivers. In the firſt was a ſound apple; in the ſecond an apple bruiſed, and repoſited looſly in the open veſſel; in the third was alſo a bruiſed apple, and repoſited in the veſſel, but the cover was ſo fitted to the veſſel, that it did ſtraitly compreſs the parts of the apple; for I was deſirous to know, whether the bruiſed apple would produce air *in vacuo*, as well as the ſound one, provided his parts were narrowly conjoined: but the iſſue was, that in the exhauſting of the receiver, the air, formed between the parts of the apple, did expel all the juice.

Nov. 21. IN the firſt receiver the height of the mercury was five digits; in the ſecond, three digits; in the third, none at all.

Nov. 23. IN the firſt receiver the height of the mercury was ſeven; in the two others there was no change,

Dec. 7. IN the firſt receiver the height of the mercury was 11 digits. There was no alteration in the other two.

Jan. 23. THE firſt receiver was now ſevered from his cover by the force of the air produced anew. In the two others there was no air generated,

May 20, 1679. THIS day the third receiver was found forced from his cover; whereas the ſecond had produced no air.

THIS experiment informs us, that bruiſed fruits do produce leſs air *in vacuo* than ſound ones, contrary to what happens in common air. The reaſon whereof may perhaps be this, that fruits bruiſed are very much rarefied *in vacuo*, and ſo the ſeveral principles, of which they conſiſt, cannot act upon one another: but unbruiſed fruits, by reaſon of the entireneſs of their ambient ſkin, undergo leſs rarefaction.

ARTICLE XV.

Air is ſometimes found unfit to produce mouldineſs.

EXPERIMENT I.

July 12, 1678. I PUT roſes into two receivers, which were to be ſtopped with ſcrews. One of them contained common air uncompreſſed; but I intruded ſo much air into the other, as ſuſtained the mercury 60 digits above its wonted height.

Aug. 2. THE roſes in the common air, four days ago, were turned into a yellow colour, as if they had been withered: but thoſe in the compreſſed air kept their colour very well,

Feb. 10, 1679. THE roſes, in the compreſſed air, as yet retained their freſh colour.

THIS experiment, compared with that, which was made the year before with roſes, doth inform us, that the air, at divers times, is diverſly affected; ſo that ſometimes it hath a power to hinder corruption, and ſometimes to promote it. See *Artic*. IV. *Exper*. IV.

EXPERIMENT II.

May 22. FIFTEEN days ago I included two equal quantities of flowers in two receivers; into one of them I thruſt ſo much air, as ſuſtained the mercury 60 digits above its wonted height; but in the other I left common air incompreſſed. The flowers were tulips and larkſpurs.

SINCE that time no mouldineſs appeared, except only, that 10 days ago, one half of a tulip, being cut in two, in the common air ſeemed ſomewhat mouldy: but this day, the other half of the ſame tulip, in compreſſed air, ſeemed to be infected with ſome mouldineſs.

As for the flowers, ſome of them ſeemed as freſh as when they were firſt put in, eſpeciallo thoſe in the common air; for in the compreſſed air they ſeemed more moiſt.

June 22. No more mouldineſs appeared; whence we have a confirmation of the inference drawn from the former experiment, *viz.* that the air is ſometimes unfit to produce mouldineſs; ſeeing the year before all thoſe kind of flowers had contracted a great deal of mouldineſs.

ARTICLE XVI.

Experiments concerning the change of weight made by the beams of the ſun, even in veſſels ſealed hermetically.

EXPERIMENT I.

Sept. 4, 1678. I EXPOSED one drachm of minium in an open glaſs to the ſun beams, concentrated in a burning glaſs, and I found, that it had loſt $\frac{3}{4}$ of a grain of its weight, though much of the minium had not been touched by the ſolar-rays.

EXPERIMENT II.

Sept. 6. I TOOK coral, already calcined in fire, and endeavoured to calcine it further by the beams of the ſun in a ſealed glaſs, but I could ſcarce produce any good effect; yet the whiteneſs of the calx of the coral was ſomewhat increaſed.

Sept. 10, I EXPOSED the ſame coral again to the ſun-beams, in the ſame glaſs hermetically ſealed, for two whole hours; and weighing the glaſs, found, that the loſs of its weight was about $\frac{1}{16}$ part of a grain, ſince the time it was firſt ſealed.

EXPERIMENT III.

May 23. I PUT calx of tin in a light glaſs phial, ſealed hermetically, and weighed it exactly: afterwards I expoſed it to the beams of the ſun for a long time, by the help of a large burning-glaſs; then the glaſs, being again weighed, ſeemed to have loſt $\frac{1}{34}$ part of a grain of its weight.

May 29. I REPEATED the ſame experiment, only uſing minium inſtead of calx of tin, and the loſs of weight came to $\frac{1}{33}$ part of a grain.

May 30. I ENDEAVOURED to burn the ſame minium again; but ſuch plenty of air was produced, that the glaſs broke into an hundred pieces, and made a great noiſe at its diſſilition.

June 6. I TRIED the ſame experiment again with minium, and then $\frac{1}{34}$ part of a grain was abated of the weight.

WHEN I attempted again to burn the minium, the glaſs broke a ſecond time.

July 15. I TOOK coals made of wood, for the ſame experiment; but the ſun did not affect them at all.

July 20. I EXPOSED vive ſulphur to the beams of the ſun, after the manner before deſcribed; and though it was eaſily melted, and did emit many fumes, yet I found no change at all in the weight.

Aug. 1. I KEPT the ſame phial ſtill with the flower of ſulphur, and expoſed it often to the fire of my burning-glaſs, without danger of being broken, *viz.* becauſe ſulphur produceth no air; but the fumes were emitted as at the firſt, and the ſulphur bubbled up; but the weight ſeemed not to be changed.

ARTICLE XVII.

The preſervation of bodies in compreſſed liquors.

EXPERIMENT I.

Auguſt 3, 1678. I INCLUDED two apricocks in two receivers, one of which was exactly filled with raiſins of the ſun bruiſed, and with water; but in the other there were only ſome raiſins encloſed, yet ſo, that the apricock was not touched, neither by the raiſins, nor by the water.

Sept. 10. I TOOK out the apricock, incloſed with the water; and whilſt the air did break forth, the fruit did bubble very much: the raiſins had loſt almoſt all their taſte, but the apricock had preſerved a pleaſant reliſh; yea, it ſeemed more pleaſant than the taſte of ſuch fruits bought at that time of the year uſeth to be.

Feb. 10, 1678. THE apricock, incloſed without water, as yet kept its colour and figure, only ſeemed to have loſt its firmneſs.

THIS experiment informs us, that the taſte of ſome fruits may be preſerved in an infuſion of raiſins of the ſun; at leaſt in veſſels, which are able to contain a great compreſſion of the air.

EXPERIMENT II.

Sept. 17, 1678. I INCLUDED peaches, with an infuſion of raiſins, in two receivers, ſhut with a ſcrew.

Sept. 21. Too great a quantity of air, produced in one of my receivers, expelled ſome part of the liquor out of it. The other receiver as yet retained its liquor.

Sept. 25. THE receiver, out of which the liquor was expelled, loſt ſome more thereof, ſo that its fifth or ſixth part now ſeemed empty: but ſetting the ſcrew, the liquor was then preſerved. The other receiver was not altered.

Sept. 26. The ſame receiver began again to leak and run over, ſo that I ſet the ſcrew again.

Nov. 27. Our receiver ſeemed hitherto to be ſhut exactly enough, but this day I opened it, and, whilſt the air was getting out, the peaches bubbled very much; one of them, of the ſort of thoſe, to which the ſtone or kernel uſeth to ſtick, had preſerved its firmneſs, and afforded a taſte pleaſant enough; but the other, being of that ſort, which are of a yellow colour, was very ſoft, yet the taſte thereof ſeemed to be more pleaſant than the taſte of the other. The liquor was very pleaſant and grateful.

Dec. 28. As yet the other receiver ſeemed unaltered; but when I opened it, an innumerable company of bubbles did emerge from the liquor, and from the peach. The peach on one ſide had preſerved its firmneſs, on the other it had loſt it; but the whole peach was acceptable to the palate, yet ſomewhat ſharp.

This experiment ſeems to teach us, that liquors may grow ſour, though no ſpirits have evaporated from them.

EXPERIMENT III.

Sept. 20. I included peaches, with unripe grapes, in two receivers, and filled them exactly. In the one were apples bruiſed to the conſiſtency of a pultis: in the other, an infuſion of raiſins of the ſun.

Sept. 25. The receiver filled with pulp of apples hitherto ſeemed unaltered; but in the other, the air which was generated had extruded the half of the contained liquor, and impelled the mercury into the gage, to the height of 100 digits; wherefore I opened the receiver, and the peach, whilſt the air was getting out, was almoſt reduced to the conſiſtency of a pultis; the taſte of it was pleaſant enough.

I put another peach into the ſame receiver, and ſubſtituted a new infuſion of raiſins of the ſun, inſtead of that, which was loſt.

Sept. 26. The mercury was now come to 30 digits above its wonted height.

Sept. 27. The height of the mercury was 72.
28. The height of it was 90. The liquor did work out.
30. The ſame height remained, but the liquor was all gone out.

Octob. 1. I now perceived, that all the air had alſo eſcaped; wherefore opening the receiver, I found the peaches very ſoft, yet of a pleaſant taſte.

Octob. 3. The receiver filled with the pulp of apples had as yet loſt nothing; but this day I perceived, that almoſt all the juice of the apples had run out: I opened the receiver, and found all therein very much fermented. The peach was very ſoft, but in taſte not unpleaſant.

This experiment informs us, that fruits cannot be long kept in pulp of apples, by reaſon of the great production of air; though that happens a little later in the infuſion of raiſins.

EXPERIMENT IV.

Sept. 23, 1678. I included peaches with crude grapes in two receivers, one of which was exactly filled with pulp of apples, the other with unripe grapes bruiſed.

Octob. 1. The receiver filled with pulp of apples ſeemed as yet to have received no alteration; but the other was this day found emptied of his wine: this therefore I opened, and found one of the peaches to have retained its firmneſs, and its taſte; but the other had loſt its firmneſs, yet retained a grateful taſte.

Feb. 5, 1679. The receiver containing the pulp of apples hitherto ſeemed unaltered; yet I opened it, and the great ebullition thereupon did manifeſt, that a mighty compreſſion of the air was in it. The pulp of apples and the peach had kept a grateful taſte, but ſomewhat more pungent than ordinary.

This experiment ſhews us, that juice of crude grapes cannot conveniently be uſed for the preſervation of fruits, by reaſon of the production of too much air.

EXPERIMENT V.

Sept. 25, 1678. I included two pears, called butter pears, in a receiver exactly filled with pulp of apples.

Sept. 28. Hitherto I perceived no alteration in the height of the mercury.

Octob. 5. The mercury was now come to the height of 15 digits.

Octob. 6. The height of the mercury was 16 digits and more.

Octob. 12. The mercury was not changed.

Octob. 20. Three days ago the mercury was depreſſed, though nothing had eſcaped out.

Octob. 26. This day my receiver was found cracked, though I did not find, that the air was compreſſed within; but perhaps the ſcrew was ſet too high. The pulp of the apples was of a very grateful taſte; ſo were the pears, but they were very ſoft, and one of them ſeemed to incline to rottenneſs.

Perhaps the crack in the receiver was the cauſe, why ſo little air was produced in this experiment.

EXPERIMENT VI.

Oct. 1, 1678. I incloſed peaches in two receivers, one of which was filled with pulp of apples, and the other with unripe grapes bruiſed.

Octob. 5. Much air was produced in the ſecond receiver, yet ſome of the wine ran out. The height of the mercury was 64 digits.

Octob. 6. The wine proceeds to run out: the height of the mercury was 70.

Octob. 8. Now the wine was all run out of the receiver, and the height of the mercury was 86.

Octob. 12. The height of the mercury abode at 86.

Octob. 18. That receiver, out of which all the wine was run, yet held the air very well; and the height of the mercury in it, ſtaid at 86. The other receiver, filled with pulp of apples; had for theſe five laſt days ſuffered ſome juice to flow out.

Dec. 4. I opened the receiver filled with pulp of apples; and though all the juice was got out, yet it ſtill contained the air, very much compreſſed; and many bubbles brake forth, not without ſome noiſe, after the receiver was quite opened. The peach was very ſoft, and of a pungent taſte, like to that of inebriating wine.

Jan. 28, 1679. After the effuſion of the wine in the other receiver, the mercury ſtaid in the ſame height. I opened the receiver; the peaches did emit many bubbles, and were wrinkled, but their colour was little changed: their ſapor was moſt pungent, and inclining to acid.

This experiment doth confirm the concluſions of the former.

Experiment VII.

Octob. 4, 1678. I put peaches into three receivers; the firſt of which was filled with ale, or beer without hops; the ſecond with beer hopped; the third with wine.

Octob. 5. The height of the mercury in the firſt receiver was 15 digits; in the ſecond, 10, in the third, 9 digits.

Octob. 6. The height of it in the firſt receiver was 25 digits; in the ſecond, 15; in the third, 20.

Octob. 8. The height of the mercury in the firſt receiver, was 35 digits; in the ſecond, 15; in the third, 20.

Octob. 12. The height in the firſt receiver was 63 digits; in the ſecond, 15; in the third, 28.

15. The height of the mercury in the firſt receiver was 81 digits; in the ſecond, 15; in the third, 30.

16. There was no more change perceived in any of the three receivers.

18. The mercury rather deſcended than aſcended, in all the three receivers.

22. In the wine only, the mercury aſcended or deſcended according to the heat and the cold.

24. The height of the mercury in the firſt receiver was 96 digits; in the ſecond, 15; in the third, 30.

30. The height in the firſt receiver was 115 digits; in the ſecond, 20; in the third, 30.

Novem. 3. The height in the firſt receiver was 117 digits; in the ſecond 20; in the third, 30.

6. The height in the firſt receiver was 120 digits; in the ſecond 31; in the third, 31.

11. The height of the mercury in the firſt receiver was 105 digits; in the ſecond, 31; in the third, 28. It was cold weather.

Novem. 16. The height of the mercury was the ſame. The peach, which hitherto was demerſed, now mounted up to the upper part of the liquor in the ſecond receiver; all the reſt ſtaid in the bottom.

Novem. 25. The height in the firſt receiver was 140 digits; in the ſecond, 47; in the third, 32.

Novem. 28. The height in the firſt receiver was 96 digits; in the ſecond, 36; in the third, 28. It was very cold weather.

Dec. 13. The height in the firſt receiver was 96 digits; in the ſecond, 47; in the third, 33. I opened the third receiver, and found the peach firm, and of a laudable colour; but it had contracted much of taſte from the wine, which yet was capable of being amended by ſugar, ſo that a very pleaſant and edible diſh might be made thereof. The wine alſo was grateful to the palate.

Dec. 30. The height of the mercury in the firſt receiver was 96 digits; in the ſecond, 47. I opened the firſt receiver, and the peaches, which had lain till then at the bottom of the liquor, did preſently emerge to the upper part thereof; they emitted many bubbles: the taſte of the ale, of which they had contracted much, was made pleaſant with ſugar.

This experiment informs us, that fermented liquors may be uſeful for the preſervation of fruits, as being unfit to produce air.

Experiment VIII.

Sept. 5, 1678. I included one peach not cut, with another cut into pieces, in a receiver; into which I after poured old wine, till it was exactly filled, and then ſhut it with a ſcrew. I hoped the iſſue would have been, that if the wine did extract any tincture from the peach, that the cut peach would eaſily ſupply it; and ſo the whole peach would keep its full taſte.

Nov. 20. As yet nothing ſeemed to be altered; but this day I perceived, that ſome of the wine did run out.

Nov. 30. The third part of the wine was loſt.

Decem. 8. Seeing the wine begin again to run out, and that there was little of it left, I opened the receiver, and found the peaches very much fermented, yet endued with a grateful, but moſt pungent taſte. The wine alſo was pleaſant.

By this experiment, if it be compared with the third receiver in the former experiment, we may conjecture, that wine doth hinder the fermentation of peaches, if it be in a ſufficient quantity; but here the wine was not ſufficient, becauſe the pieces of that peach, which was cut, did fill the whole receiver, ſo that no room was left for the wine, but in the interſtices.

EXPERIMENT IX.

Octob. 11, 1678. I put two peaches, one whole, the other cut in pieces, into a receiver filled with hopped and fermented beer.

Octob. 12. In one night's ſpace the mercury aſcended three digits.

Oct. 15. The height of the mercury was 15 digits.
16. The height of it was 15.
18. The height of it was 12. It was very cold.
20. The height of it remained at 12.
22. Now the mercury aſcended again. The cold abated.
Nov. 2. The height of the mercury was 20.
3. The mercury deſcended a little. It was cold weather.
6. The height of the mercury was 28. The weather grew hotter.
8. The height of it was 33.
11. The height of the mercury was 40.
12. The height remained at 40. Some of the beer wrought out.
16. The height of it was 46.
19. The height of it was 43. But much of the beer was loſt.
21. The mercury aſcended not, but the beer proceeded to work out.
23. When the beer was almoſt all wrought out, I opened the receiver, and found the peaches very ſoft, yet of a grateful taſte, though they had been kept nine hours in the free air, after the receiver was opened.

N. *Theſe fruits were never quite ripe.*

From this experiment, if it be compared with the ſecond receiver in *Exper.* VII. it may be inferred, that beer doth hinder the fermentation of peaches, and the production of air, if it be in a ſufficient quantity: but here there was but a little beer contained in the interſtices, which was not able to hinder the fermentation of the peaches.

EXPERIMENT X.

Octob. 19, 1678. I included raw beef in three receivers; the firſt of which was exactly filled with ſtale beer, forcibly intruded, ſo that the mercury exceeded its wonted height by 60 digits. The ſecond was alſo exactly filled with ſtale beer, but here there was no compreſſion made. The third was filled partly with the beef, and partly with common air.

Octob. 20. In the firſt receiver the mercury was depreſſed to the twentieth digit beyond its uſual height, though nothing at all had eſcaped out. In the ſecond alſo, it deſcended a little; but in the third, it aſcended ſomewhat.

Octob. 26. In the firſt receiver the mercury did ſometimes aſcend, and then deſcend very irregularly; in the ſecond it began to aſcend ſlowly two days ago; in the third it was not moved at all.

Octob. 27. One piece of the ſame beef, which was left in the air, began to have an ill ſmell; and alſo the mercury in the third receiver began to aſcend. In the ſecond it proceeded to aſcend by little and little; but in the firſt it ſeemed rather to deſcend.

Nov. 3. The mercury in the firſt receiver aſcended not; in the ſecond, the height of it was 20 digits; in the third, it was 10 digits.

Nov. 5. I opened all the receivers, and the two firſt did not ſtink at all, yet they had contracted a ſmell from the beer; the fleſh boiled in the ſame beer was found very tender, but its taſte was bitter, perhaps by reaſon of the too great quantity of the beer. That beef, which was included with common air, when the receiver was opened, did preſently affect the noſtrils with a ſtinking ſmell; yet, when it was taken out, and accurately ſmelt too, it ſcarce ſeemed to ſtink. I included the ſame fleſh in the ſame receiver, to try, whether new air being admitted would promote corruption.

Nov. 6. The height of the mercury was three digits.
11. The height of it was 9.
25. The height of it was 20 digits.

I opened the receiver; I found the fleſh ſo ſtinking, that I was forced to throw it away.

From this experiment it ſeems to follow, that beer may be convenient for the preſervation of fleſh, eſpecially if it be intruded by force into the receiver; but this compreſſion is ſoon abated, becauſe the air compreſſed in the ſame receiver is apt to enter into and pervade the pores of the beer by degrees.

EXPERIMENT XI.

Nov. 12. I included beef, as hardly as I was able to do it, in three receivers: into the firſt of them I poured water, mixed with one fortieth part of ſalt, which filled up all the interſtices, which were left betwixt the parts of the fleſh: in the ſecond ſome ſalt water was in like ſort contained; but it was intruded by force, ſo that the mercury in the gage aſcended to 15 digits above its wonted height: into the third receiver I poured no water, and therefore thoſe few interſtices, which could not be poſſeſſed by the fleſh, were left for the air.

Nov. 13. The mercury deſcended in all the receivers, eſpecially in the ſecond, which had admitted the compreſſed liquor.

Nov. 18. The two receivers, which were not compreſſed, did not repel the depreſſed mercury upward: but as for that, whoſe mercury had been impelled to 15 digits, and afterwards had deſcended moſt of all, it now returned almoſt to its former height. A piece of the ſame beef, being left in the air, began to have a bad ſmell.

Nov. 23. In the three receivers air was produced a new; but this day in the ſecond the mercury deſcended three digits; the height of it was 20: in the other two it was about 16. I opened the firſt receiver, and the fleſh was not corrupted at all.

Nov. 30. I took the fleſh out of the receiver, which was put in without ſalt; it did not ſtink at all; but being boiled, was very tender and of a pleaſant taſte.

Dec. 6, I opened the receiver, into which I had forcibly introduced ſalt water. The mercury exceeded its wonted height 25 digits. The ſmell of the fleſh did ſtrongly affect the noſtrils, yet it did not ſtink. The fleſh put *in vacuo* ſent forth many bubbles, which ceaſed not but a pretty while after the receiver, in which it was included, was taken out of the pneumatic engine; yet the mercury, in one hour's ſpace, came to the height of three or four digits. Afterwards I immerſed the ſame receiver ſo exhauſted in hot water, and the liquor contained therein did bubble very much, though the water from which it borrowed all its heat did not boil at all; but ſo great a quantity of air was produced, or elſe had entered from without, that the receiver was quickly full. Afterwards the liquor contained therein did not bubble or boil, though it were immerged in boiling water. I took out the fleſh, and found it pleaſant and tender, yet leſs ſo than I expected, perhaps becauſe it was not yet boiled enough.

This experiment teacheth us, that water, as well as beer, may conduce to the preſervation of fleſh.

Experiment XII.

Nov. 29, 1678. I inclosed oyſters in four receivers: in the firſt the oyſters were without their ſhells, and filled the whole ſpace as exactly as we could; in the ſecond, the oyſters, not taken out of their ſhells, were included with common air: in the third, the oyſters alſo were included in their ſhells, and the remaining ſpace of the receiver was exactly filled with ſalt water. All theſe three veſſels were firmly cloſed with ſcrews. The fourth receiver was exhauſted of air, and it contained three oyſters in their ſhells, and eight taken out of their ſhells. When the air was pumped out of this receiver, the oyſters, which were taken out of their ſhells, did emit many bubbles, and thoſe very great ones; but the three others underwent no ſenſible mutation, ſave that one of them did gape.

Nov. 30. In the three recipients, which were ſtopped with ſcrews, the air ſeemed to be conſumed, rather than produced; but the mercury *in vacuo* aſcended a little.

Dec. 4. Whilst the weather was cold, the mercury aſcended not; but now when the cold began to abate, the height of the mercury in the firſt receiver was ſeven digits; in the ſecond, none; in the third, three; in the fourth, three.

Dec. 5. The height of the mercury in the firſt receiver was 20 digits; in the ſecond, one digit; in the third, three; in the fourth five.

Dec. 7. The height of the mercury in the firſt receiver was 30 digits; in the ſecond, one digit; in the third, three; in the fourth, eight. Other oyſters, left at the ſame time in the air, had a bad ſmell.

Dec. 9. In the firſt receiver the height was 30; in the fourth, 11. The reſt were not changed.

Dec. 13. There was no change in the three firſt receivers, but in the fourth the height was 14 digits.

Dec. 20. In the firſt receiver the height was 46 digits; in the fourth, 24; the reſt were not changed.

Dec. 21. In the firſt receiver the height was 52 digits; in the fourth, 25: in the reſt no change.

Dec. 22. The height of the mercury in the firſt receiver was 60; in the fourth, 27: no change in the reſt.

Dec. 27. In the fourth receiver the height was 29; the reſt were not changed.

Jan. 1, 1679. The oyſters in the third receiver had tinged the water with a black colour.

Jan. 25. The mercury *in vacuo* ſeemed ſtill to remain almoſt in the ſame height. But this day ſome bubbles were formed in the turpentine, by the internal air, about the commiſſure of the cover with the receiver. Therefore I opened the receiver, and found the oyſters very ſtinking; I likewiſe opened the other receivers, and found the oyſters of a ſtinking ſmell, and turned to a kind of viſcous gelly.

This experiment ſeems to inform us, that fiſhes do produce leſs air than fleſh; and yet that they will be corrupted, though they are fortified againſt the air.

Experiment XIII.

Nov. 29, 1678. I exactly filled a glaſs veſſel with freſh butter, not at all ſalted, and then ſtopped it with a ſcrew. A mercurial gage was included in the ſame veſſel.

Nov. 30. In the night, the cold being very ſharp, the butter was condenſed, for the mercury came nearer to the aperture of its gage.

Dec. 2. The mercury came nearer and nearer to the aperture of its gage, perhaps becauſe the cold did daily increaſe.

Dec. 5. The cold being abated, the mercury returned almoſt to its former height; part of the ſame butter, being left in the air, began to have a very bad ſmell.

Dec. 7. The cold again returning, the mercury did alſo again come to the top of its gage. The butter left in the air ſmelt worſe than before, notwithſtanding, as yet, it was edible.

Dec. 24. The butter had produced no air; being taken out of the receiver, it was of a grateful taſte, except only a little of the ſuperficies, which was contiguous to the leather, that was ſpread over the cover.

From this experiment it follows, that butter may be kept a great while, if it be defended from the contact of the external air.

Experiment XIV.

Nov. 30, 1678. I filled two receivers with whitings; and that no air might be left in the vacant ſpaces, into the one I poured wine; into the other oyſters, with their juice, without their ſhells; ſo that both the receivers were exactly filled. When I had afterwards cloſed their covers with ſcrews, the air in the mercurial gages was compreſſed; but in three hours ſpace the mercury again returned to its former mark.

Dec. 2. The cold increaſing, the mercury came nearer to the aperture of its gage in both receivers.

Dec. 4. The cold ceaſing, the mercury aſcended very much in that receiver wherein the oyſters were; but in the other receiver it was not moved.

Dec. 5. In the receiver containing the oyſters, the height of the mercury was 20 digits; but in the other, it was not yet returned to its wonted height.

Dec. 7. In the receiver with oyſters, the height of the mercury was 40 digits; in the other, it continued ſtill below its wonted height.

Dec. 9. The mercury in both receivers was changed little or nothing.

Dec. 20. When the mercury was changed no more, I opened the receivers, and both of them were found to be very ſtinking. And this ſeemed new to me in this experiment, that the receiver, in which the wine was, had admitted of corruption without production of air; for hitherto all bodies, whilſt they were corrupting, had produced air.

Experiment XV.

Dec. 3, 1678. I put raw beef into two large receivers, with pepper and cloves; and that no air might be left in the interſtices, I poured in beer upon them, and no long time after I found the preſſure of the air in the receivers to be abated, the mercury in the gages coming to the open ends.

Dec. 8. The mercury did not aſcend in either of the receivers. I opened the one, that I might boil the fleſh; it was endued with a ſweet ſmell, contracted from the cloves; and the liquor contained in the ſame receiver, before it was boiled, did ſmell like hippocras.

Jan. 2, 1679. I opened the other receiver, and found no air produced therein; the fleſh was not at all corrupted, and when I boiled it *in vacuo*, I obſerved, that if a more intenſe fire were kindled, the air, or ſome ſpirits, did make an eruption through the ſtop-cock, which was faſtened to the top of the receiver. The receiver, being cooled all the night, the day after was found almoſt quite empty of air. The fleſh was very tender, and well taſted, only it was a little over-boiled, for it had been kept on the fire ſix full hours.

We have a confirmation by this experiment, that beer may be uſeful for the preſervation of fleſh, eſpecially if the bitter taſte thereof be corrected by ſome aromaticks.

Experiment XVI.

Dec. 4, 1678. I included two larks, with ſome beef, in a receiver, all whoſe ſpaces, unpoſſeſſed by the fleſh, I filled with ale; and at the ſame time I filled another receiver with the ſame ſort of beef, adding beer alſo, but no larks were put in with it.

Dec. 9. Some pieces cut off from the larks, and expoſed to the air, began to ſmell ill; but thoſe included in the receiver, as yet had produced but little air; for the mercury was not yet come to five digits above its wonted height. In the other receiver it was not moved.

Dec. 19. In the receiver, which contained the larks, the mercury aſcended no higher; for the cover being broken, ſuffered the liquor to run out. Wherefore I opened the receiver, and boiled both the beef and the larks, which were not at all corrupted, but they ſeemed very acceptable to the palate; yea the beef had contracted a pleaſant taſte, partly from the larks, and partly from the beer.

Dec. 23. I opened the other receiver, and the boiled fleſh ſeemed pleaſant, yet not ſo pleaſant as that, which was endued with a veniſon-like taſte from the larks.

This experiment ſhews, that even tender birds may be preſerved long by the help of beer or ale.

Experiment XVII.

Dec. 14. I included apples in four receivers; in the firſt was an whole apple, and all the ſpaces were filled with powdered ſugar: in the ſecond, an apple was cut in pieces, and the ſpaces filled with ſugar, as before: in the third an apple was alſo cut, but the reſt of the receiver was filled with water, wherewith $\frac{1}{10}$ part of ſugar was mixed: in the fourth, the apple was alſo cut, and the ſpaces were likewiſe filled with a ſolution of one part ſugar, and five parts of water.

Dec. 21. This day, in the firſt receiver, the mercury began a little to aſcend, yet the ſugar did not melt: in the ſecond receiver all the ſugar was melted, and the pieces of apple were ſhrivelled, alſo they produced much air when they were firſt put into the receiver. In the two other receivers the mercury began alſo to aſcend; but in the third, the pieces of apple were very much corrupted, for their ſkin or rhine was taken off.

Dec. 22. Air was produced in all the receivers, but the quantities of the air produced, did not bear the ſame proportion amongſt themſelves, as the quantities of the ſugar: for in the ſecond receiver much air was produced, but in the fourth the mercury aſcended leſs than in the third; and beſides, in the firſt ſome air was generated.

Dec. 27. IN the three firſt receivers the height of the mercury was ten digits; but in the fourth it was only ſix digits.

Dec. 31. IN the firſt and ſecond receivers the height of the mercury was 13; in the third the height was 15; in the fourth it was only nine digits.

Jan. 2, 1679. IN the firſt and ſecond receivers the height of the mercury was almoſt 14; in the third 17; in the fourth 11.

Jan 7. IN the ſecond receiver the height of the mercury was 16 digits; in the third 36; in the fourth the height of it was 15: but in the firſt the mercury had not aſcended, and ſomething had eſcaped out of the receiver, and therefore I eaſed the ſcrew, that I might diſpoſe of it the better; and then the air made an eſcape.

Jan. 9. IN the firſt receiver the height was ſix digits; in the ſecond 16; in the third 39; in the fourth 15.

Jan. 17. IN the firſt receiver the height was 13; in the ſecond 19; in the third 56; in the fourth 17.

Jan 30. IN the third receiver the height of the mercury was 76 digits, and the liquor brake out, and therefore I opened it, and found the fruit to have loſt much of its taſte, but the water had contracted it, and was pleaſant enough to the palate. In the ſecond receiver the mercury aſcended no more. I opened this receiver alſo, and found the fruit much more pleaſant in this than the other; yet much of its taſte was imparted to the ambient ſugar, ſo that it was found changed into a very good ſyrup.

Feb. 16. THE height of the mercury in the firſt receiver was 22 digits; but in the fourth 33. I opened it, and found the fruit to have loſt much of its taſte, and that the ambient water had got it, and was thereby turned into a pleaſant drink.

Feb. 27. IN the firſt receiver the height of the mercury was 30 digits.

March 15. IN the firſt receiver the height of the mercury was not changed; but this day I found ſomething to eſcape out of the receiver, and therefore I opened it, and found the apple of a laudable colour; but the pulp was ſpungy, and had loſt much of its taſte.

THIS experiment ſeems to teach us, that ſugar is not ſo fit for the preſervation of fruits, as fermented liquors. See *exper.* 7.

EXPERIMENT XVIII.

Dec. 23. I filled a glaſs veſſel with milk, and then ſtopped it with a ſcrew; and into another receiver I put a lark with milk, and ſtopped it cloſe.

Dec. 24. THIS evening I perceived, that the caſeous part was ſevered from the butyrous, in the cloſed receivers as well as in the milk, which, at the ſame time, I had left expoſed to the air.

Dec. 27. I found no air produced in the receiver, which held the lark; but in the other, the mercurial gage was ſpoiled.

Dec. 31. THE mercury aſcended in that receiver, which contained the lark; but the milk, that was left in the air at the ſame time, that I ſtopped the receivers, did ſtink three days ago.

Jan. 1, 1679. IN the receiver, wherein the lark was included, the height of the mercury was 10 digits.

Jan 2. THE height of the mercury was 14½. The milk ſtagnant below the butyrous part appeared of a red colour.

Jan. 4. THE height of the mercury was 19. Some white ſediment was concreted in the bottom of the milk.

Jan. 9. THE height of the mercury was 29 digits.

Jan. 25. I opened both receivers, and found the lark to affect the noſtrils with a ſtrong, though no fœtid ſmell, yet it had been kept 32 days; when it was boiled, it was of a pleaſant taſte. In the other receiver, the caſeous part of the milk was ſubacid and grateful, but the butyrous part was not ſower at all.

THIS experiment informs us, that ſometimes milk may be uſed with good ſucceſs for the preſervation of fleſh.

EXPERIMENT XIX.

Dec. 24, 1678. I put a lark into a ſmall receiver, and poured butter upon it, melted with a ſlow fire, till all the ſpaces were exactly filled; then I cloſed the cover with a ſcrew.

Dec. 27. THE mercury approached nearer to the aperture of its gage; but the butter ſeemed to be altered, for the loweſt part of it was more yellow, and the middle more white than it ſeemed before the incluſion thereof: the upper part was fluid.

Jan. 5, 1679. THE mercury returned by little and little, to its wonted height.

Jan. 9. THE mercury was ſomewhat higher.

Jan. 28. THE mercury was little changed: I opened the receiver, and found that part of the butter, which was contiguous to the leather ſpread over the cover, to be white, and of a very unacceptable taſte. The butter, which was more remote from the leather, was yellow and ſomething graveolent, yet it was edible. But the lark being roaſted was grateful to the palate, though it had been kept 34 days.

THIS experiment ſeems to inform us, that butter melted and hot is not ſo ſucceſsfully uſed for the preſervation of fleſh.

EXPERIMENT XX.

Jan. 4, 1679. I included boiled fleſh *in vacuo*, in a receiver ſtopped with a ſcrew, and filled the interſtices exactly with broth of the ſame fleſh, which ſeemed a little too ſalt. Whilſt I ſet the ſcrew all the things in the receiver ſuffered a compreſſion, and the mercury aſcended to the height of ſix digits into the gage; but ſhortly after it returned to its wonted height.

Jan. 18. The air was more and more conſumed, ſo that the mercury now deſcended to eight digits below its wonted height. I opened the receiver, and found the fleſh very ſweet and tender. The broth alſo had a ſubacid, but a very grateful taſte.

This experiment informs us, that fleſh, after it is boiled, may be kept long without prejudice, which is a great conveniency in long voyages at ſea; ſo that perhaps there will be no need of ſalted fleſh. For after the raw fleſh hath been kept ſo long in veſſels ſtopped with ſcrews, till experience ſhews, that there is no danger of its corruption, then it is to be taken out, and being perfectly boiled, is again to be included in the ſame receivers: and ſo without doubt it may be kept for a long time without ſalt. See *exper.* 12.

Experiment XXI.

Jan. 30, 1679. I put raw fleſh into two receivers: to the firſt I added pepper and cloves; in the ſecond I mixed nothing, for I was willing to know, whether theſe ſpices would promote the production of air, or retard it.

Feb. 11. The height of the mercury in the firſt receiver was three digits; in the ſecond the height of it was below $1\frac{1}{2}$.

Feb. 12. The height of the mercury in the firſt receiver was $4\frac{1}{2}$; in the ſecond not above $1\frac{1}{2}$.

Feb. 13. In the firſt receiver the height of the mercury was ſix digits and more; in the ſecond it was three digits. I boiled the fleſh of the firſt receiver, after the manner before deſcribed, and it was very pleaſant and tender.

Feb. 14. The height of the mercury in the ſecond receiver, was five digits.

Feb. 19. The height of the mercury in the ſecond receiver, was eight digits.

Feb. 20. The height of the mercury in the ſecond receiver was 11 digits. I boiled the fleſh and found it very tender, though it had ſtaid over the fire *in balneo Mariæ* only for three quarters of an hour. I put ſome part of this fleſh, before it was boiled, into a receiver, and filled all the ſpaces as exactly as I could with the ſame fleſh, to try how long the fleſh might be preſerved when the air was ſo excluded.

Feb. 28. The mercury aſcended very little.

March 20. The height of the mercury was about 16 digits. I opened the receiver, and the fleſh ſeemed of a pleaſant taſte, yet inclining to corruption.

Experiment XXII.

Feb. 10. I put raw beef into three receivers: in the firſt, the beef was ſeaſoned with pepper and cloves; in the ſecond, it was encompaſſed with ſalt water; in the third, I put neither ſalt nor ſpice.

Feb. 19. Four days ago the mercury aſcended in the third receiver; in the firſt alſo it began to aſcend; but in the ſecond it was not moved at all.

Feb. 21. In the firſt receiver the height of the mercury was four digits and $\frac{1}{2}$; in the third 10 digits; but in the ſecond there was no aſcent at all.

Feb. 25. The height of the mercury in the firſt receiver was ſix digits; in the third 19 digits; in the ſecond half a digit.

Feb. 26. This night there was no aſcenſion of the mercury in all the receivers. I opened the third receiver, and the fleſh, after boiling, was found very good.

The former experiment ſeems to teach us, that ſpices do hinder the production of air; but the preſent experiment proves the contrary. Whence this contrariety ſhould proceed, I know not; unleſs it be, becauſe, perhaps, I had left a ſpace large enough for the air in theſe receivers; but in the former experiment I filled all as exactly as I could with fleſh.

March 9. The height of the mercury in the firſt receiver was eight digits; in the ſecond none.

March 12. The height of the mercury in the firſt receiver was 12 digits; in the ſecond one digit.

April 3. The height of the mercury in the firſt receiver was 11 digits: but in the ſecond it exceeded not one digit. I opened the receiver, and boiling the fleſh, after my accuſtomed manner, I found it very tender, and of an excellent taſte.

The corollary from this experiment ſeems to be, that the ſaltneſs of water, included with fleſh, doth hinder the production of air; but becauſe there was ſo ſmall a quantity of water, compared with the quantity of fleſh, I do rather incline to think, that leſs air was produced in the ſecond receiver, becauſe it was more exactly filled. And indeed, if freſh water had been uſed inſtead of ſalt, the matter ſucceeds after the ſame ſort; but the chief art to preſerve fleſh without ſalt conſiſts herein, that all air be excluded from it, and that there be a great compreſſion in the receiver.

All theſe experiments about the preſervation of aliments, what great uſe they may be of for the tranſporting of fruits, veniſon, or other fleſh, from places far remote to great cities, and for the affording better nouriſhment to mariners, I leave to the reader to judge.

ARTICLE XVIII.

Experiments concerning elixation and diſtillation in vacuo.

Experiment I.

Dec. 12, 1678. I PUT two ounces and ſix drachms of beef into an empty receiver, which was able to hold 22 ounces of water, Then I put it into boiling water for three hours; which being done, I expoſed it to the air to be cooled for a whole night; afterwards, uſing my pneumatic engine, I perceived, that the air formed in the receiver could ſcarce ſuſtain three digits of mercury; and ſo deducting from the calculation, a man may eaſily find, that fleſh, whilſt it is boiled, cannot form air enough to make an entire preſſure in a receiver capable of holding a double weight of water: that is, if you include one pound of fleſh in an emptied receiver, able to hold two pounds of water, it will not generate air, that can remove the cover from the receiver, unleſs heat do confer much to produce the effect; but I confeſs, that our fleſh was not boiled enough.

See the deſcription of a veſſel to boil and diſtill in vacuo, *p.* 105.

EXPERIMENT II.

Dec. 23. I incloſed three ounces of raw beef in a receiver able to hold 32 ounces of water; and when it boiled, having been long on the fire, the cover was forced from its receiver, and ſo ſuffered the vapours to paſs out; but becauſe it was preſently ſhut again, the fire being removed, the receiver ſoon loſt its internal preſſure, ſo that being ſet again to the fire, it was a long time before it could force away the cover the ſecond time. I tried this again and again; yea, unleſs the receiver had been expoſed to a very ſtrong fire, the cover could never have been removed; but if the fire be kindled enough, ſweet exhalations continually paſs out.

Dec. 24. THE receiver, having been cooled during the whole night, was this day, by the uſe of the pneumatic engine, almoſt wholly evacuated. Whence we ſeem to have a confirmation, that the divulſion of the cover is not made by that air, which can keep the form of air, but from the ſteams exhaling from the fleſh, and ſubſiding again therein, if they be hindred from egreſs, which may eaſily be performed, if we uſe not too fierce a fire in the empty receiver, and ſo the loſs of thoſe ſweet ſmelling vapours may be eaſily avoided.

EXPERIMENT III.

Jan. 21. 1679. I put paſte, without leaven, into an exhauſted receiver; and alſo I included another part of the ſame paſte in another receiver, full of common air. I encloſed theſe two receivers *in balneo Mariæ*, ſtopped with a ſcrew; and when they had ſtaid there for three hours, having been expoſed to a moderate fire, I opened the receivers: the paſte *in vacuo* I found reddiſh, as far as the ſuperficies; but the other had admitted water; and the paſte was not boiled enough, and therefore I put both receivers again *in balneo Mariæ*, where they ſtaid an whole night.

Jan. 22. THIS day in the morning, I found the *balneum Mariæ* quite cold; and the paſte, when it was taken out, was boiled enough, but it was covered with no cruſt. That, which was included *in vacuo*, was interſperſed with many cavities, but it ſeemed too inſipid; the other contained no cavities, but afforded a more pleaſant taſte. Both the receivers were found almoſt wholly emptied of air.

EXPERIMENT IV.

Feb. 3, 1679. I ENCLOSED paſte kneaded with leaven *in vacuo*; and, as ſoon as it had filled its receiver with factitious air, I tranſmitted it into that receiver, which I am accuſtomed to uſe to boil fleſh *in balneo Mariæ*; but when the paſte was thus removed out of one receiver into another, it pitched or ſunk very much; yet when it had remained for three hours in a fervid *balneo Mariæ*, the bread made of it was interſperſed with many cavities, but it was covered with no cruſt.

Feb. 5. I ITERATED the ſame experiment; but this time the paſte was included *in vacuo*, in the ſame receiver, which was afterwards put *in balneo Mariæ*, and therefore there was no need to remove the paſte, and expoſe it to the air. Hence it came to paſs, that the bread made thereof was much lighter than the former.

EXPERIMENT V.

Feb. 12. I INCLUDED roſemary with water in the veſſel deſcribed p. 105. and when the air was pumped out, I put the veſſel *in balneo arenæ*, and there came forth a water endued with a very ſweet ſmell; yea, and ſome drops of eſſential oil, ſmelling very ſweet alſo, and affected with no *empyreuma*. But when I opened the ſtop-cock for to let in the air, the noiſe did ſo ſoon ceaſe, that I judged much air was produced from the roſemary.

Feb. 13. I PUT the ſame roſemary into the ſame evacuated veſſel, and adminiſtred a more intenſe fire thereunto; yet I could extract no oil, neither ſweet nor ſtinking; and beſides, the water was leſs fragrant than the former.

EXPERIMENT VI.

Feb. 10, 1679. I BOILED one pound of fleſh *in vacuo*, in the veſſel deſcribed p. 105, which could contain almoſt four pounds of water: the upper part thereof, which was made of glaſs, did hold the mercurial gage, by the help whereof I perceived, that the mercury had not aſcended to the height of three digits, though the fleſh had boiled for three hours and more. It was not boiled enough, and its taſte was ungrateful; and moreover the liquor, which was formed of the condenſed vapours, afforded alſo an unpleaſant taſte.

Feb. 11. I ITERATED the former experiment, but this time I ſprinkled the fleſh with pepper and cloves; the iſſue was, that the mercury aſcended to the height of ſix digits, though the fiſh was boiled no longer than the other: it ſeemed very grateful to the palate, and the liquor formed from the vapours afforded a moſt pungent taſte of pepper; but it had contracted nothing ungrateful from the fiſh, as was done in the former experiment.

FROM theſe experiments made about elixation and diſtillation *in vacuo*, the corollary ſeems to be, that ſuch veſſels may be very uſeful for the diſtilling and boiling of ſuch bodies, which do contain thin and very volatile ſpirits; for all things will be preſerved by their help, and nothing will avolate or fly away.

ARTICLE XIX.

Concerning elixation in veſſels ſtopped with ſcrews, by the help whereof, even hartſhorn, and the bones of fiſhes, and four-footed Creatures may be ſoftned.

EXPERIMENT I.

Jan. 29. EIGHT days ago I filled a veſſel, ſtopped with a ſcrew, with beef and water together, and when it had continued expoſed to a moderate fire, for eight or nine hours *in balneo Mariæ*, ſtopped alſo with a ſcrew, I took the fleſh out of it; but it was boiled a great deal too much, and the taſte of it was very unpleaſant. Afterwards, I boiled new beef in the ſame veſſel, and after the ſame manner, ſave that this was ſeaſoned with pepper and cloves, and remained expoſed to the fire only for three hours. The iſſue was, that this fleſh preſerved a moſt pleaſant taſte: wherefore that I might know, whether the excellency of this fleſh above the other, did proceed from the ſpices, or from a ſhorter time of boiling, I boiled other fleſh without ſpices for three hours, in the ſame veſſel, and after the ſame manner: when the fleſh was taken out, it was of a good taſte. Whence I conjectured, that the cauſe of ſpoiling the firſt fleſh was to be chiefly aſcribed to the over-boiling; yet I think, that the ſpices may be convenient to correct ſome part of the ungrateful taſte; for I left a place for the condenſing of the vapours, in the top of the veſſel, and found, that the liquor there formed was of an unpleaſant taſte; but when the fleſh was ſeaſoned with pepper and cloves, no ſuch thing was found.

EXPERIMENT II.

Jan. 29. I BOILED apples, after the ſame manner as I did the fleſh before deſcribed; but I mixed no water with them. They were ſet upon a moderate fire almoſt for two hours. They were very ſoft, and of a very good taſte, but ſome pieces, which were laid in the upper part of the receiver, where the vapours aſcending from the inferior part were condenſed, were found of an unpleaſant taſte; and alſo the drops, formed from the ſame vapours, did affect the noſtrils with an ungrateful odour.

EXPERIMENT III.

Feb. 4. I INCLOSED fleſh, with pepper and cloves, in a receiver ſtopped with a ſcrew, but poured no water in to fill the interſtices; only I compreſſed the fleſh, as much as I could, and then I put the receiver *in balneo Mariæ*, already hot, and ſtopped it with a ſcrew; and when it had remained there, over a moderate fire, for a whole hour, the fleſh was rather over-boiled than under-boiled: but when I opened the *balneum Mariæ*, all the water brake out of it with a great force, *viz.* the liquor being hot, and hitherto incarcerated, now having freedom given, at length did ſhew its ſtrength.

Feb. 5. I INCLOSED ſome part of this fleſh in a receiver ſtopped with a ſcrew.

March 12. THE fleſh, which was included five weeks ago, was this day found very good. I do not doubt, but that perfect elixation was able to contribute ſomething to its preſervation, *viz.* becauſe the ſundry principles of which fleſh conſiſteth, had, whilſt the heat continued, exerted their ſtrength upon one another, far better than if the fleſh, being leſs boiled, by reaſon of the great avolation of parts, had been to be removed from the fire, as it happens in ordinary coctions. And indeed, by experiments made about other bodies, I have found that elixation, the perfecter it is, doth ſo much the more hinder fermentation. See *artic.* xvii. *exper.* 12, 20.

EXPERIMENT IV.

Feb. 10. I BOILED an ox-foot or cow-heel, after the ſame manner as I had done the fleſh above-mentioned, but I left the cow-heel for four hours or more, upon a moderate fire. That time being elapſed, and the veſſels unſtopped, the fleſh was excellently well boiled, and the bones were ſo ſoft, that they might be cut with a knife, and eaten like cheeſe.

Feb. 12. I REPEATED the ſame experiment, but the veſſels remained expoſed to the fire for twelve hours ſpace; and though the water of the *balneum Mariæ* did every where ſecure the veſſel demerſed in it, yet the fleſh had contracted a taſte and a ſmell very *empyreumatical*; but the juice, which in the former experiment did concrete into a very firm gelly, in this latter could not be congealed at all.

BY theſe experiments it appears, that many bones and hard tendons, which we daily caſt away as unprofitable, by the help of *balneum Mariæ*, ſtopped with a ſcrew, may be converted into good nouriſhment.

EXPERIMENT V.

Feb. 10. I BOILED a fiſh, after the ſame manner as was deſcribed above, *in balneo* *mariæ* ſtopped with a ſcrew, but I mixed no water therewith. The fiſh ſtaid upon the fire two hours only; then the veſſel being cooled and opened, the fiſh was found of a very good taſte, and his bones were ſo ſoft, that they yielded to the preſſure of one's finger, and the head of it could be eaten like its fleſh. The juice of it, in a ſhort time, did concrete into a gelly of an hard conſiſtence.

THIS experiment is very uſeful for the boiling of fiſh, which are full of bones.

EXPERIMENT VI.

Feb. 15. I PUT harts-horn into a receiver, which was to be ſtopped with a ſcrew, and filled the intervals with water. I included the receiver, thus ſtopped, *in balneo Mariæ* ſtopped alſo with a ſcrew, and ſo expoſed it for four hours to a moderate fire; when that time was paſſed and the veſſels opened, the harts-horn was as ſoft as cheeſe, and the juice did ſoon concrete into a very firm gelly.

Feb. 17. I REPEATED the ſame experiment, but no water was included with the harts-horn, and the fire laſted ſix hours under the *balneum Mariæ*: when this was done, the harts-horn was found very ſoft, but a little juice had excreted out of it, and that did adhere to the external parts of the harts-horn in the form of drops of gelly.

THE excellency of this *balneum Mariæ* is confirmed by this experiment: for ſeeing harts-horn itſelf can be boiled by the help thereof, without the mixture of water, there is no doubt, but all freſh water, which is wont to be ſpent in ſhips to boil fleſh, may be preſerved for other uſes of the mariners. Furthermore, if we add what we have tried about the preſervation of raw fleſh, and after of that, which is boiled, (See *exper.* 3.) doubtleſs we may conceive great hope, that many inconveniences, which are wont to prejudice mariners, both by reaſon of the ſaltneſs of their meat, and the putrefaction of their water, will be almoſt wholly remedied and prevented. Neither let any man object, that ſo many veſſels, and ſo exactly ſtopped, are very difficult to be procured; for daily experience doth evince, that very many mechanical inſtruments, far more difficult, may, in a little time, become very eaſy for uſe, and as eaſily procurable.

A LETTER OF *Mr.* BOYLE's *to the learned Dr.* JOHN BEAL, *Fellow of the Royal Society, concerning freſh water made out of ſea-water, printed at the deſire of the patentees, in a tract intitled,* Salt water ſweetned, *by* R. FITZGERALD, *London* 1683, *in* 4to.

SIR,

TO give you a ſhort account (ſuitable to the little time I have to do it in) of the tranſaction, which I ſuppoſe muſt have given the riſe to the mention made of my name in the publick gazette, I muſt inform you, that one of my neareſt relatives, (Captain *Fitzgerald*) and ſome other worthy gentlemen, having acquainted his majeſty, that they had an invention for making ſea water ſweet and wholſome, in great quantity and with ſmall charge, and that I had examined, and did approve the water ſo prepared; his majeſty was pleaſed, with very gracious expreſſions, to command me to attend him with a further and more particular information. Having readily obeyed this order, and been made acquainted with the objections the king thought fit to make againſt the practicableneſs of the invention, which (though a private man had urged them) I ſhould think the moſt judicious, that have been framed againſt it; I humbly repreſented to him, that I looked upon this invention as compriſing two different things; a *mechanical* part, which related to the engine itſelf, and the uſe of it a ſhip-board, and a *phyſical* part, which concerns the potableneſs, and wholeſomeneſs of the liquor. About the former of theſe I did not pretend to clear the difficulties, eſpecially ſuch ſtrong ones as his majeſty had propoſed, but left it to the patentees to give him ſatisfaction, which they were in a readineſs to offer: but as to the wholſomeneſs of the prepared water, I had made ſome trials upon that liquor, which gave me no juſt grounds of ſuſpecting it to be unwholſome, but ſeveral motives to believe it well conditioned, and of great uſe to navigators, and not to them only. And having hereupon briefly acquainted his majeſty with the chief trials I had made to examine this ſweetned water, he was pleaſed to look upon them as ſatisfactory; and vouchſafed, on that occaſion, to diſcourſe as a virtuoſo of the ſea, and brackiſh waters, and gave me ſome new, as well as inſtructive obſervations about them; and, in concluſion, diſmiſſed the patentees with a gracious promiſe of his royal protection and peculiar favour.

To this ſhort narrative it now remains, that I briefly ſubjoin the chief things, that perſuaded me of the ſalubrity of this water, whence may be juſtly and eaſily inferred the utility the publick may receive by a cheap and eaſy way of preparing it. Firſt then, I conſidered, that almoſt all the rain water, that falls from the clouds on the main ocean, and which (except perhaps in very few places in torrid climates) is unqueſtionably received as wholſome, muſt be afforded by the ſea, and conſequently be but ſea water, freed from its ſalt; (according to the famous motto, *redit agmine dulci.*) Next I found, as his majeſty himſelf had done, that the liquor was well taſted, and without any ſenſible brackiſhneſs; and ſo ſome of it continued for between four and five months in a large chryſtal bottle, that I purpoſely kept unſtopped, and for the moſt part in a ſouth window, where it neither did, nor probably in a long time will, putrify, nor ſo much as appear troubled, or leſs tranſparent; during which time it was, with approbation, taſted and ſmelled by ſeveral learned phyſicians of the famous college of *London*. Thirdly, I found it laver very well, which moſt pump waters, and many others, that have ſome little (though unperceived) common ſalt in them, will not do. Fourthly, this water will boil peaſe tender, which, amongſt ſeamen, is one of the principal ſigns of good water. Fifthly, in very good balances, with an inſtrument that I purpoſely cauſed to be made for the nice weighing of liquors, I found this water far leſs heavy than one would expect; for if it differed at all in weight from the like quantity of undiſtilled water, (I ſpeak with an *if*, becauſe it is far more difficult to be exact in ſuch nice trials, than the unpractiſed will imagine) the difference was not conſiderable, being but between the 400 and 500th part of the weight of the common water; and that difference is very ſmall, in compariſon of that, which navigators and learned authors relate to be obſervable in natural waters, all of them good and potable. I might tell you on this occaſion, that the laſt great duke of *Tuſcany*, who was an eminent virtuoſo, and the patron of the celebrated academy of Lyncean philoſophers, is affirmed, among other prudent courſes, that he took for his health, whereof he was very ſollicitous, to have conſtantly made uſe of diſtilled water for his own drinking. And I could add other things, favourable enough to the patentees water, if haſte, and perhaps diſcretion too, did not oblige me to leave them yet unmentioned, that I may now have time to ſay ſomewhat of the main thing of all, that convinced me of the ſaltleſſneſs of the water I ſpeak of. I conſidered then, ſixthly, that the thing, that was aimed at by thoſe ingenious men, that, at differing times and in ſeveral countries, have attempted to make ſea water ſweet; and the thing, that was required, by propoſing recompences, or otherwiſe to encourage the makers of ſuch attempts, was to free the ſea water from brackiſhneſs, without any noxious additament: ſo that on all ſides it was taken for granted, that the only thing, that kept the ſea water from being ſafely potable, was its brackiſhneſs; from which reflection it was natural for me to infer a concluſion very favourable to our prepared water. For having long ſince written a ſhort diſcourſe of the ſaltneſs of the ſea, I had been induſtrious to deviſe ways of comparing waters in point of brackiſhneſs: and by theſe I found the patentees water to be more free from common ſalt, than waters, that are uſually drank here in *London*, of which I remember I ſhewed thoſe gentlemen an experiment, that ſurpriſed as well as convinced them; and that, which more ſatisfied me myſelf, was a trial, that I carefully made by a way, which having mentioned, but not yet, for want of opportunity, diſcloſed to his majeſty, the reſpect I owe him forbids me to impart it without his leave: on which account, I hope, you will be content to be at preſent aſſured of theſe two things; one, that, by this way of trial, I found what poſſibly you will think ſtrange, that if there were in water ſo much as one grain of ſalt in above two ounces of water, I could readily diſcover it; and the other, that even by this critical examen, I could not detect ſo much as a thouſandth part of ſalt in our prepared water; whereas I found, by trials purpoſely and carefully made, that our Engliſh ſea water contained a 44th or 45th part of good dry ſalt, or which is all one, that 44 pints, or near ſo many pounds of marine water, would yield about one pound of dry common ſalt.

Thus, Sir, you have a ſhort and artleſs account, ſuch as my haſte will permit, and the nature of the ſubject requires, of my part in promoting this profitable invention, to which I own myſelf a great well-wiſher, not out of any private intereſt, (though that were obligingly proffered me by the patentees) but as I think the bringing it into general uſe may prove a real ſervice to mankind, upon the ſcore of divers utilities and advantages, which yet, though I had leiſure, I ſhould think very needleſs to enumerate to ſo diſcerning a perſon as Dr. Beal; to whom I ſhall therefore haſten to ſubſcribe myſelf

an affectionate friend and ſervant,

R. BOYLE.

MEMOIRS
FOR THE
NATURAL HISTORY
OF
HUMAN BLOOD,
ESPECIALLY
The SPIRIT of that LIQUOR.
WITH AN
APPENDIX.

The PREFACE introductory, addreſſed to the very ingenious and learned Dr. *J. L.*

I WILLINGLY acknowledge, that divers phyſicians have amply and learnedly, and ſome of them very eloquently, ſet forth the praiſes of the blood, and manifeſted how noble and excellent a liquor it is. But I muſt beg their pardon, if I doubt, whether their writings have not better celebrated its praiſes, than diſcovered to us its nature. For, though the laudable curioſity of the moderns has acquainted us with ſeveral things not delivered to us by the antients; yet, if I miſtake not, what is generally known of human blood, is as yet imperfect enough, and conſiſts much more of obſervations than experiments; being ſuggeſted far more by the phænomena, that nature her ſelf has afforded phyſicians, than by trials induſtriouſly made to find what ſhe will not, unſollicited by art, diſcover. I will not be ſo raſh as to ſay, that to mind (as too many anatomiſts have done) the ſolid parts of the body, and overlook enquiries into the fluids, and eſpecially the blood, were little leſs improper in a phyſician, than it would be in a vintner to be very ſollicitous about the ſtructure of his caſk, and neglect the conſideration of the wine contained in it. But though I will not make ſo bold a compariſon, yet, when I conſider how important a part of the human body the blood is; and that, as when it is well conſtituted and does orderly move, it conveys nouriſhment, and vigour, and motion, and in a word health, to the reſt of the living engine; ſo the maſs of blood being either vitiated, or (which is very often the effect of that depravation) diſorderly moved, is the ſeat of divers, and the cauſe of moſt diſeaſes, whoſe cure conſequently depends mainly upon the rectifying of the blood: when, I ſay, I conſider theſe things, I cannot but think it an omiſſion, that ſo important a ſubject has not been more ſkilfully and induſtriouſly enquired into. But, I hope, you were not in earneſt, when you ſollicited me to repair that omiſſion; for, you know I have not the vanity to pretend to be a phyſician; and being none, I muſt want both the ſkill and many opportunities, wherewith a man, that were profeſſedly ſo, would be advantaged. And though I deny not, that many years ago I propounded to ſome ingenious phyſicians a hiſtory of the fluid parts of the body, ſuch as the humours and other juices, and alſo the ſpirits of it, and did particularly draw up a ſet of enquiries, and make divers experiments in reference to the blood; yet thoſe papers being ſince loſt, and a long tract of time, and ſtudies of a quite other nature, having made me loſe the memory of moſt of the particulars, I find myſelf unable to contribute any thing conſiderable to your laudable deſign. And as all the ſearch your commands obliged me to make after my papers, has hitherto proved fruitleſs, ſo they having been written, when I had far more health, vigour, and leiſure, than I now have, and when my thoughts were much more converſant with medicinal ſubjects; any thing, that I ſhall now preſent you about the blood, will not only be extremely ſhort of what ought to be ſaid, but will alſo be ſhort even of what, if I miſtake not, I did ſay of it. But yet all this is ſaid, not to excuſe me from obeying you at all, but to excuſe me for obeying you ſo unſkilfully. For, ſince you will have me ſet down what I can retrieve about human blood, you ſhall receive it in the following paper, which conſiſts of four parts; the firſt whereof contains a ſet of titles (which I call of the firſt order, for reaſons to be given you in the advertiſements about them) towards the natural and medical hiſtory of human blood, which may direct thoſe, that want better guides, what enquiries to make, and to what heads to refer what they have found by obſervation or trial. But becauſe this part contains but bare titles (whoſe ſyſtem, yet, perhaps I look upon as likely to make the uſefulleſt part of the enſuing papers) and becauſe I have neither leiſure nor materials to anſwer all or moſt of the titles; I thought fit, in a couple of ſubjects, namely, the ſerum of human blood, which is a natural, and the ſpirit, which is a factitious part of it, to give ſome inſtances of what I had thoughts to do on others; and propoſe ſome example to thoſe, that may be more unpractiſed in drawing up natural hiſtories, than the general deſign and courſe of my ſtudies of natural things permitted me to be: and what is ſaid on theſe two ſubjects, makes the third and fourth part of theſe papers. As for the other titles (of the hiſtory of the blood) I contented myſelf, in compliance with my haſte, to ſet down what occurred to me in the caſual order, wherein they offered themſelves; without ſcrupling to mingle here and there, among the hiſtorical notes, ſome experiments, that I formerly but deſigned as trials, that might prove luciferous, whatever the event ſhould be. This rhapſody of my own obſervations makes one of the four parts, and the ſecond in order, of what your commands embolden me to offer you at this time. And I ſhall be very glad to be ſo happy as to find, that by doing a thing, that I am wont to do ſo delightfully as to obey you, I have, by breaking the ice, contributed ſomething to ſo noble and uſeful a work as the hiſtory of human blood. About which, that I may not make the porch much too great for the building, I ſhall add to this preamble nothing but theſe two advertiſements; of which the firſt ſhall be, that it is not my deſign in theſe papers, to treat of my ſubject, as it may be conſidered (to borrow a ſchool phraſe) *in fieri*, which would have obliged me to trace the progreſs from the reception of aliments at the mouth, to the full elaboration, which were to write the hiſtory of ſanguification as well as that of blood; but to treat of this liquor, as it is completely elaborated, and that too, not as it is formed in the veſſels of a living body, but as it is extravaſated, and let out by the lancet; ſuch blood alone being that, on which I had ſome opportunity to make trials. And to this firſt advertiſement I ſhall ſubjoin as the ſecond, that in the following papers I have, as the title intimates, treated but of ſuch human blood, as was taken from ſound perſons; both becauſe, being no profeſſed phyſician, I had not the opportunities of examining that of ſick perſons moleſted with particular diſeaſes, (which yet would much conduce to a complete hiſtory of the blood;) and becauſe the knowledge of the nature of the blood, when it is rightly conditioned, is neceſſary to thoſe, that would diſcern, in what particulars, and how far it deviates in the ſick, according to that generally received axiom, *Rectum eſt index ſui & obliqui*: on which account the ſcheme of titles drawn up for the hiſtory of healthy blood may ſerve for a direction to any, that would write the hiſtory of morbid or depraved blood in any particular diſeaſe, as a pleuriſy, a quartan ague, the dropſy, the ſcurvy, *&c.* For having compared the qualities and accidents of this vitiated blood, with thoſe of the blood of ſound men delivered in the forementioned ſyſtem of titles, it will not be difficult for a phyſician to find, to what heads he is to refer thoſe things, that conſiderably recede from ſuch as belong to healthy blood. And theſe receſſions or depravations, with perhaps a few additions of ſome peculiarities, if any occur, will make up the hiſtory of the blood, as it is wont to be vitiated in that particular diſeaſe; one general admonition ſufficing (if that itſelf be not unneceſſary) to make the reader take notice, that in all other points the blood of perſons ſick of that diſeaſe is not unlike that of thoſe, that are healthy.

The Natural History of Human Blood.

PART I.

Containing a liſt of titles for the hiſtory of human blood. To which are premiſed ſome advertiſements about them.

THAT the ſcope and meaning of the enſuing ſcheme of titles, (and divers others, that I drew up for differing ſubjects) may be the more clearly underſtood, I muſt lay down in this place ſome paſſages borrowed from the (unpubliſhed) eſſay or letter I wrote to Mr. *Oldenburg*, ſecretary to the Royal Society, about the way of compiling a natural hiſtory. I propoſed then in that tract three ſorts of heads, to which the particulars, that might occur, and properly belong to the hiſtory of the ſubject to be treated of, whether a body, or a quality, or an operation, or a proceſs, (that is, a progreſſive change) might conveniently be referred. Theſe diſtinct ſets of topics or enquiries I call orders, ranks, or claſſes; and becauſe to each of theſe ſets it was found by experience, that things of ſomewhat differing nature were to be referred, as queries more properly ſo called, propoſitions either affirmative or negative, and other heads of natural hiſtory, that are leſs fit to be reduced to either of the two former ſorts, than to be looked upon as ſubjects to be treated of; for this reaſon, I ſay, among others, I thought fit to compriſe all theſe ſorts of particular topics, or articles of inquiry (to uſe our illuſtrious *Verulam*'s phraſe) under the general and comprehenſive name of titles.

THE firſt order or claſſis of theſe titles, I would have to conſiſt of ſuch, as occurred readily enough to my thoughts upon the firſt deliberate view, or general ſurvey, of the ſubject to be treated of. For it is ſcarce to be expected, that at the firſt attempt a man ſhould be ſo clear ſighted, or ſo happy, as to pitch, or light upon as direct and compendious ways of indagation, and as good methods of digeſting and delivering what is diſcovered, as when a ſtudious enquiry has furniſhed him with better informations about the ſubject he is to treat of: and therefore it may ſuffice for the firſt time, that the mind do, as it were, walk round the object it is to contemplate, and view it on every ſide, obſerving what differing proſpects it will that way afford, (as when a painter, or an anatomiſt, looks upon a man's body, firſt when the face and belly are towards him, then when the back and other hinder parts are ſo) and that it takes notice of the limits and boundaries of it, and of the moſt eſſential and conſiderable parts or other things that belong to it. Wherefore in the firſt claſſis of titles, one need not be too ſcrupulous about the enumerating and marſhalling the particulars referable to it, but may be more ſollicitous, that the titles ſhould be various and comprehenſive enough, than that they ſhould be nicely methodical; and much leſs than that they ſhould be accommodated to any particular hypotheſis. And becauſe, even at the firſt deliberate view, ſome (though perhaps very few) of theſe titles may appear conſiderable and fertile enough to deſerve, that there ſhould to each of them be referred two or a greater number of ſubordinate and more particular topics; I thought fit, for method's ſake, to call the capital titles, that is, thoſe of the firſt claſſis, primary titles, and the ſubordinate, ſecondary ones. [Of which diſtinction a notable inſtance will be met with in what is hereafter delivered, about the ſpirit of human blood; all the ſixteen titles, together with the appendix, contained in that epiſtolary diſcourſe, being ſecondary titles referrible to that primary one, which is the eighteenth in the firſt claſſis of the hiſtory of human blood.]

WHEN by reading, conference, meditation, and (which is here mainly to be conſidered) the trials ſuggeſted in the topics of the firſt claſſis or order, the naturaliſt has received the beſt and fulleſt information he can procure of all, that belongs to the ſubject he is to treat of, he may then proceed to frame another ſet of titles, which may be called the ſecond; or (if no other interpoſe) the laſt order or claſſis of them, which, if he have been diligent and any thing proſperous, will be much more copious and better ranged than the firſt.

FOR now divers things will in likelihood appear to belong to the ſubject of the hiſtory, which were not at firſt taken notice of to do ſo, yea, perhaps were not at all thought of; and the further diſcovery made of the nature of the thing treated of may direct the hiſtorian to range his topics, or titles, in a better order, and more natural method, than thoſe of the firſt claſſis. And, which is a thing of far greater moment, divers, and perhaps moſt, of the particular titles will appear to be of greater extent, or more comprehenſive, than they were formerly conceived to be: ſo that a particular title may well be thought fit to be branched into many ſubordinate topics, or articles (which we lately called ſecondary titles) ſome one of which may perhaps compriſe as many experiments, or obſervations, as it was at firſt gueſſed would appertain to the prime or more general title itſelf. And from the materials orderly drawn together under this laſt ſet or claſſis of titles, with ſome requiſite changes in point of method and connexions, and ſome additional things, as tranſitions, *&c.* by the help, I ſay, of ſuch alterations and additions, the particulars whereof the laſt order or claſſis conſiſts, may be digeſted and framed into an inchoate natural hiſtory of the ſubject they have relation to; I ſaid, an inchoate hiſtory, to intimate, that even after all that has been already done, I think it too probable, that the hiſtory will hereafter appear to have been rather begun then compleated; the nature of things, and the induſtry of ſkilful men, being ſo very fertile, that the knowledge of the ſubject of the hiſtory will from time to time be increaſed; and ſo the hiſtory itſelf may be enlarged and corrected, but will not, I fear, in many ages, if ever it be at all, be made abſolutely perfect.

AND on this occaſion I muſt add, that when the ſubject to be treated of is very comprehenſive or very difficult, as the generation of living creatures, magnetiſm, fermentation, gravity, *&c.* it may be very uſeful, if not almoſt neceſſary, to interpoſe, between the titles of the laſt and thoſe of the firſt claſſis, a ſet of titles, that may be called of the middle order, or claſſis. For the framing whereof, the hiſtorian is conſiderately and narrowly to reſurvey the nature of the ſubject, and make a heedful collation of that, and of the ſeveral notices attained by his endeavours to furniſh the differing titles of the firſt claſſis with a competent number of particulars. For, by this collation, there will in all likelihood be ſuggeſted to him many new topics of enquiry, and hints, which, added to the former, will deſerve to have a new claſſis framed conſiſting of articles more copious and various than the firſt, and fit to be ranged in another order. It may perhaps illuſtrate what I have been ſaying, and am going to ſay, about the ſeveral claſſes of titles, if on this occaſion I ſhall add, that a natural ſubject being propoſed to be hiſtorically treated of, there may occur ſomething like what happened to the *Iſraelites* in reference to the land of *Canaan*. For at their firſt entrance into it, *Joſhua* and the other ſpies took a tranſient view of the country, and could bring back but an unaccurate account of it, together with a little of the moſt remarkable fruit; but upon a ſecond expedition, the ſpies were furniſhed with fuller inſtructions, and ordered to direct their reſearches to the anſwering of a great many particular articles of enquiry; their induſtry to anſwer which produced, in methodical tables or ſchemes, a far more copious and diſtinct chorography and ſurvey of the fruitful land of *Canaan*.

It is ſcarce to be expected, that at the very firſt time the titles, whether primary or ſecondary, of a natural hiſtory ſhould be made ſo comprehenſive, and be ſo ſkilfully bounded, as not to need to be either enlarged or reformed by ſecond thoughts, and a further progreſs in the practical knowledge of the ſubject treated of. I therefore thought it neceſſary, or at leaſt uſeful, to ſubjoin to the firſt edition of the titles of each of the natural hiſtories I delineated, a mantiſſa or appendix, that ſhould conſiſt of two ſorts of particulars, *viz.* Paralipomena and other Addenda; whereof the firſt ſhould contain ſuch things as may be properly referrible to ſome one or more of the titles, (either primary or ſecondary,) diſtinctly enumerated in the ſcheme of the hiſtory, and were but by haſte or overſight kept from having place among them: the other conſiſts of new particulars, that, after the hiſtory was written, were ſuggeſted by further diſcoveries; whether theſe particulars did directly belong to any of the preceding titles, or might only in a general way contribute ſomewhat to the knowledge, or illuſtration of the ſubject.

TITLES of the firſt ORDER.

For the natural hiſtory of human blood of healthy men.

1. OF the colours of human blood arterial and venal.

2. OF the taſte of human blood.

3. OF the odours of human blood.

4. OF the heat of freſhly emitted human blood.

5. OF the inflammability, and ſome other qualities of human bload.

6. OF the aerial particles naturally mixed with human blood, and alſo found in its didiſtinct parts.

7. OF the ſpecific gravity of human blood entire.

8. OF the ſpecific gravity of the two obvious parts of human blood, the red (and fibrous) and the ſerous.

9. OF the conſiſtence of entire human blood.

10. OF the diſpoſition of human blood to concretion, and the time wherein it is performed.

11. OF the liquors and ſalts, that coagulate human blood.

12. OF the liquors and ſalts, that impede or diſſolve its coagulation.

13. OF the liquors, *&c.* that preſerve human blood.

14. OF the mixtures, that human blood may admit from aliments.

15. OF the ſpontaneous or natural analyſis of human blood into a ſerous and a fibrous part.

16. OF the reſpective quantities of the ſerous and fibrous part of human blood.

17. OF the differences between the ſerous and the red part of human blood.

18. OF the artificial or chymical analyſis of human blood, and firſt of its ſpirit.

19. OF the volatile ſalt of human blood, and its figures.

20. OF the phlegm of diſtilled human blood.

21. OF the two oils of human blood.

22. OF the fixt ſalt of human blood.

23. OF the *Terra Damnata* of human blood.

24. OF the proportion of the differing ſubſtances chymically obtained from human blood.

25. OF the fermentation or putrefaction of human blood, and its phænomena.

26. OF the mechanical uſes of human blood, as in huſbandry, *&c.*

27. OF the chymical uſes of human blood.

28. OF the medicinal uſes of human blood.

29. OF the difference between human blood, as it is found in perſons differingly conſtituted and circumſtantiated, as men, women, (when menſtruous, and when not) children, Moors, *&c.*

30. OF the affinity and difference between the blood of men, and that of divers other animals, as quadrupeds, birds, fiſhes, and ſanguineous inſects.

An APPENDIX, containing

1. PARALIPOMENA, relating to the hiſtory of human blood.

2. MISCELLANEOUS obſervations, experiments and enquiries about human blood (to be added to the hiſtory of it.)

I DO not think it unlikely, that ſome of the titles of our intended hiſtory of blood, and a greater number of the particulars, that you will meet with in it, may ſeem frivolous to you at the firſt peruſal. But, perhaps, in proceſs of time, theſe very things will not appear impertinent, nor be found uſeleſs: for it is a matter, as of more difficulty, ſo of more utility, than men are wont at firſt to diſcern, to find out, and bring into a narrow compaſs, a conſiderable number of particulars relating to one ſubject, and preſent them, as it were, at one view to the intellect to act upon. And there is many a particular experiment or obſervation, which, upon the firſt, or perhaps the ſecond reading, may ſeem but ſlight or ſuperfluous, which afterwards is found capable of being made good uſe of by thoſe, who ſeriouſly intend, and endeavour to to attain, not a maimed or a ſuperficial, but a deep and ſolid knowledge of the ſubject of their enquiry. And to ſuch indagators many particulars, that at firſt were paſt by unregarded, becauſe there appeared no direct uſe or obvious application of them, will be found ſerviceable to hint new hypotheſes or theories, or to illuſtrate them; to examine thoſe of others, and, if they be true, to confirm them, and, if erroneous, to confute them. For, to be ſhort, the knowledge of matters of fact cannot but be ſome way or other, and probably more ways than one, ſerviceable to a naturaliſt, that has ſagacity and judgment to make a right uſe of them.

Having already advertiſed you, that the following papers treat of none but extravaſated blood, ſince I had no other at command, to make my trials upon; I preſume you will not wonder, that you find not in the ſcheme of titles ſuch as theſe.

Of the proceſs of ſanguification, or the ſeries of changes, that the aliment ſucceſſively undergoes, from its being taken in at the mouth, till it be turned into blood.

Of the motions of the maſs of blood, and particularly its circulation.

Of the chyle, lympha, and other liquors, that are ſuppoſed to enter and mingle with the blood.

Whether the humours, phlegm, gall, and melancholy, be really contained in the blood, as conſtituent parts of it.

Whether ſome other ſubſtances may not with as much reaſon be admitted into the compoſition of the blood.

These, as I was ſaying, and perhaps ſome other titles ſhould have been added, if my deſign had reached further than to treat of blood ſeparated from the body; and I wiſh that you, who by your abilities and profeſſion are far better qualified than I for ſuch a work, would fill up theſe titles, and add to them, ſome as preliminaries, and others as appendices, to the hiſtory of blood I have adventured to begin.

Perhaps it may not be altogether impertinent to add, that I had once ſome thoughts of a deſignation of a natural hiſtory of other liquors of a human body, as well as the blood; I mean ſuch as the gall, the lympha, the *Succus Pancreaticus*, ſpittle, urine, milk, &c. But I quickly perceived it was fit for me to reſign ſuch taſks to phyſicians; only I ſhall here ſubjoin, as a ſmall ſpecimen, a ſet of titles for the hiſtory of urine, which, though, by reaſon of its affinity in many regards to blood, it muſt have many titles in common with it, yet ſome will be differing according to the nature of the ſubject; which (liquor) I therefore pitch upon, becauſe I dare own to you, and I do it not without premeditation, and having wrought on urine longer than on blood itſelf, that I think urine to be a liquor, which, as much deſpiſed as it is by others, deſerves to be ſollicitouſly enquired into by phyſicians, naturaliſts, and upon ſpecial accounts by chymiſts; who will perhaps be excited to ſeek and hope for great matters, both for medicine and alchymy, from this liquor ſkilfully handled, when they conſider that the phoſphorus, of which I have elſewhere related ſo many new, and ſome of them ſurprizing, phænomena, is made, at leaſt according to my way, of meer urine by a ſimple diſtillation.

Titles of the firſt Classis.

For the natural hiſtory of human urine emitted by healthy men.

1. Of the colours of human urine.
2. Of the taſte of human urine.
3. Of the odours of human urine freſh and putrified.
4. Of the heat and cold of human urine.
5. Of the ſpecific gravity of human urine.
6. Of the conſiſtence of human urine, as to denſity, viſcoſity, &c.
7. Of the aerial particles contained in human urine.
8. Whether human urine is a fit liquor for fermentation properly ſo called.
9. Of the differences between freſh and ſtale human urine.
10. Of the fermentation or putrefaction of human urine, and the time it requires.
11. Of the ſpontaneous ſeparation of parts in human urine.
12. Of the vulgar analyſis of human urine by diſtillation.
13. Of ſome other ways of diſtilling human urine.
14. Of the proportion of the principles, or ingredients of human urine.
15. Of the ſpirits of human urine.
16. Of the phlegm of human urine.
17. Of the volatile ſalt of human urine.
18. Of the fixt ſalt of human urine.
19. Of the compounded ſalt of human urine.
20. Of the ſhining ſubſtances obtainable from human urine.
21. Of the ſalt, that is predominant in human urine.
22. Of the empyreumatical oil, or oils of urine.
23. Of the mellago, or rob of human urine, and its uſes.
24. Of the *Terra Damnata* of human urine.
25. Of ſome accidental differences of human urine, as it is emitted in the morning, or at certain diſtances from meat, or after the uſe of certain aliments, or medicaments, as ſparagus, turpentine, &c. or at differing ſeaſons of the year, as winter, ſummer, &c.

26. Of the affinity of human urine with divers other bodies, eſpecially vegetable and mineral.

27. Of the hoſtility of human urine with acids, *&c.*

28. Of the affinity and difference between urine, blood, gall, milk, *&c.* and divers other liquors, or juices belonging to the animal kingdom, particularly of the compariſon between human urine and that of beaſts.

29. Of the mechanical uſes of human urine.

30. Of the chymical uſes of human urine, and its parts, eſpecially as menſtruums.

31. Of the medicinal uſes of human urine, external and internal.

An APPENDIX, containing

1. **Paralipomena** relating to the hiſtory of human urine.

2. **Promiscuous** obſervations, experiments, and inquiries about human urine. (To be added to the Hiſtory of it.)

PART II.

Containing miſcellaneous experiments and obſervations about human blood.

IF I were furniſhed with all the former experiments, obſervations, and papers, that at ſeveral times I made and wrote about human blood, or were ſupplied with materials and opportunities to repair the want of them, (as poſſibly, God aſſiſting, I may hereafter be,) this ſecond part of our work would perhaps appear much leſs maimed, and jejune, than it will now be found. But I am ſo ſenſible of the diſadvantage, that the want of thoſe requiſite helps muſt have brought to this rhapſody of unconnected notes, (written at differing times, and on differing occaſions) that I was more than once inclined totally to omit it. And it is the importance of the ſubject, upon which even mean experiments may ſometimes prove of good uſe, that keeps me from ſuppreſſing it; which I thus early give notice of, that nothing more than looſe experiments, and thoſe referrible but to ſome of the titles of the hiſtory of human blood, (divers others being left untouched) may in the ſecond part of our memoirs be expected.

To the fourth (primary) title of the History of Human Blood.

Experiment I.

HAVING for ſome reaſons, that need not here be mentioned, been induced to inquire of more than one perſon, that has uſed to let many men blood, whether they did not obſerve, that ſome perſons found a manifeſt and conſiderable change in the heat of the blood, as it came to iſſue out firſt or laſt? I was anſwered affirmatively, and told, that ſeveral perſons, that had no fever, ſaid, that after their blood had run out a while, they found it come ſenſibly hotter than before; and ſome of them complained, that it came with a degree of heat, that was troubleſome, and, as they fancied, ready to ſcald them.

To the ſame title of the History of Human Blood.

Experiment II.

I Got a chirurgeon to put a ſealed weather-glaſs, adjuſted by the ſtandard of *Greſham* college, into the porringer, wherein he was going to bleed a young gentlewoman, that, as the blood ran out of the open vein, it might fall upon the ball of the inſtrument, in which the liquor was made by the warmth to aſcend a good way, but not much (if at all) nearer, than about an inch to the ſmaller upper ball of the thermoſcope.

To the ſame title.

Experiment III.

BUT, within leſs than an hour before this time, having procured a man of middle age (that ſeemed healthy enough, and was let blood in the ſame ſhop by the ſame chirurgeon) to bleed upon the ſame weather-glaſs, the tincted ſpirit of wine aſcended above all the marks belonging to the ſtem, and from the top of the ſtem expanded itſelf to a conſiderable quantity in the ſmall upper ball of the ſtem, (for the chirurgeon told me it was a fourth part of the height of the ball;) ſo that, though we could not determine, how high it would have riſen, if the ſtem had been long enough, yet it ſeemed manifeſt, that the warmth, that made it riſe, did conſiderably exceed the uſual warmth of the air in the dog-days; theſe gaged thermoſcopes being wont to be ſo framed, as to keep the liquor in the ſtem all the year long, without ſinking quite into the greater ball in winter, or aſcending into the leſſer in ſummer.

We employed alſo, when a young woman was blooded, a ſealed thermometer, that was not gaged, but was much ſhorter than the other; and in this the tincted ſpirit was raiſed almoſt to the top, which argued no inconſiderable degree of heat.

To the ſame title.

Experiment IV.

I Know not, whether it may be worth while to take notice on this occaſion, that a porringer, whereinto a healthy man had been let blood, having been brought from the chirurgeon's houſe to my lodging; though the blood was already coagulated, yet when I thruſt into it the ball of the forementioned gaged thermoſcope, it appeared to have retained warmth enough to make the ſpirit of wine aſcend, by my gueſs, at leaſt three or four fingers breadth above its former ſtation.

To the fifth title of the History.

SINCE human blood does, in diſtillation, afford a not inconſiderable quantity of oil, one may well ſuppoſe it to be a combuſtible body: but every one will not think it ſo inflammable, as, upon trial purpoſely made, I found it to be. For having taken a piece of human blood dried till it was almoſt pulverable, and held it in the flame of a candle, it would take fire, and afford a flame much like that, which excited it, burning with a crackling noiſe (much like that of ſea-ſalt caſt into the fire) and here and there melting. But the inflammableneſs of ſuch dried blood did much better appear, when putting together four or five throughly kindled coals, we laid on them a piece of dried blood of the bigneſs of a ſmall nutmeg, or thereabouts; for this yielded a copious and very yellow flame, and if it were ſeaſonably and warily blown from time to time, as the effluvia degenerated into ſmoak, it would, by theſe frequent re-accenſions continue to yield clear and yellow flames of no contemptible bigneſs (in proportion to the body that yielded them) much longer than one would expect. And during a good part of this deflagration, the blood appeared, as it were, to fry upon the coals, and in good part to melt into a black ſubſtance almoſt like pitch. There was alſo a crackling noiſe produced, like that, which chymiſts obſerve, when they decrepitate common ſalt.

These experiments for the ſubſtance were repeated. But I ſhewed another inſtance of the inflammableneſs of blood, that was ſomewhat ſurpriſing. For, having cauſed ſome human blood (being part of the ſame, that was made uſe of in the foregoing trials) to be ſo far dried, that it was reducible to fine powder, I took ſome of this powder, that had paſt through a fine ſearch, and caſting it through the flame of a good candle, the grains, in their quick paſſage through it, took fire, and the powder flaſhed, not without noiſe, as if it had been roſin. This experiment was reiterated with ſucceſs.

To the ſeventh title of the History.

THE ſpecific gravity of human blood is more difficult to be determined than one would readily imagine: for the gravity of blood may differ ſenſibly in ſeveral perſons, according to their ſex, age, conſtitution, &c. and in the ſame perſon it may be varied by the time of the year, and of the day, and by being drawn at a greater or leſſer diſtance from a meal, and by divers other circumſtances. But beſides all theſe things, there is a mechanical difficulty, if I may ſo call it, that attends the work we are ſpeaking of: for the blood begins to coagulate ſo ſoon after it is emitted, that it is ſcarce a practicable thing to weigh it hydroſtatically, either by immerſing into it a ſolid body heavier than itſelf, or by weighing the whole blood in water; the former way being oppoſed by the fibrous part of the blood, and the latter by the ſerum: and upon the ſame account it is ſomewhat (though not ſo much) difficult to compare with any accurateneſs, the weight of blood with that of water in a glaſs; as alſo for other reaſons, which he, that ſhall conſiderately go about to try it, will quickly find. But however, ſince it may be a thing of conſiderable uſe, to have ſome tolerable eſtimate, though not an exact one, of the difference in gravity between water and human blood, by which ſo many parts of the body, conſiſtent as well as fluid, are by various changes of texture both conſtituted and nouriſhed; I ſhall ſubjoin a trial, that this conſideration invited me to make as well as I could. We took the blood of a ſound man emitted all at one time, and put the whole maſs of it, as well the ſerous as the fibrous part, into an oblong glaſs, of the fitteſt ſize and ſhape we could light on amongſt ſeveral; and having ſuffered the blood to reſt, till all was ſettled, and the many bubbles vaniſhed, we carefully marked with a diamond that narrower part of the glaſs, which the upper ſurface of the blood reached to: then we weighed the glaſs and the blood in a very good balance, and having poured out the blood (for other uſes) and waſhed the glaſs, it was filled with common water to the lately mentioned mark, and then weighed again in the ſame balance; afterwards the water being poured out, the glaſs alone was counterpoiſed in the ſame ſcales, and its weight being deducted from each of the two formerly mentioned weights, the water was found to have weighed ℥ix. ʒvi. 50 *gr.* and the blood (equal to it in bulk) to have weighed ℥x. ʒij. 4 *gr.* ſo that the difference between them being ʒiij. 14 *gr.* the blood was heavier than ſo much water, but about the 25th part (for I omit the fraction) of its own weight. But this experiment, for the reaſons above intimated, deſerves to be reiterated more than once.

To the eleventh title of the History.

THOUGH rectified ſpirit of wine be a menſtruum conſiſting of very ſubtle parts, and upon that account be a good diſſolvent of divers vegetable ſubſtances, and, as experience has aſſured me, of ſome metalline ones too, that ſeem to be more ſolid than the fibrous part of human blood; yet looking upon this body as of a very differing texture from thoſe, I thought ſpirit of wine might have a very differing operation upon it. And accordingly, having ſeparated from the ſerum a clot of blood, that was coagulated, but ſoft enough, as the fibrous part uſes to be before it is dried, I kept it for divers hours in a very well dephlegmed vinous ſpirit, from whence I afterwards took it out as hard, as if it had been well dried by the fire.

To the nineteenth title of the History.

Experiment I.

THE volatile ſalt of human blood, as fugitive as it is, is yet ſo fuſible, that, if it be dextrouſly handled, one part of it may be brought to melt, and, as I have tried, even to boil, whilſt the reſt is flying away. The like I have tried with ſome other volatile ſalts, and I preſume the obſervation will hold in moſt, if not all of them.

To the ſame title.

Experiment II.

THOUGH the volatile ſalt of human blood, when it is by ſublimation made white and clean, ſeems to be a very homogeneous ſubſtance, and according to the principles of the chymiſts ought to be ſo; yet I am apt to ſuſpect, either that its ſubſtance is not altogether ſimilar, or that the corpuſcles, that compoſe it, are of ſizes, if not alſo of ſhapes, differing enough. For having weighed out ſome grains of a reſublimed ſalt of human blood, that ſeemed very pure, the odour was ſo ſtrong and diffuſive, that one would have expected the whole ſalt, being but ſix grains, ſhould in a few hours evaporate away, eſpecially being left in a ſouth window expoſed to the air in a flat piece of glaſs. And yet ſeveral days after, if I miſtake not, ſeven or eight, I found the ſalt ſo little diminiſhed, as to its ſenſible bulk, (for I did not think fit to weigh it) that it ſeemed to have waſted but little; and yet what remained had ſcarce any odour at all, that I (whoſe organs of ſmelling are acute enough) could well perceive, notwithſtanding which, this white body retained a ſaline taſte; and a little of it being for trial's ſake put upon a ſolution of common ſublimate in fair water, readily turned it white. So that it ſeemed, that the penetrant and diffuſive odour of the volatile ſalt of blood proceeded from ſome particles, much more ſubtile and fugitive than the other parts, that compoſed it. But this experiment ought to be reiterated with differing quantities of ſalt, by which means, perhaps, a heedful obſerver may diſcover, whether the comparative fixity of the ſalt, that remains after the odorous particles are (at leaſt for the moſt part) flown away, may not ariſe from their coalition with ſome acid corpuſcles, that are wont to rove up and down in the air, and adhere to bodies diſpoſed to admit their action.

To the ſame title.

Experiment III.

A DRAM of volatile ſalt of human blood, ſublimed in a lamp furnace, was put into as much common water, as in a narrow cylindrical glaſs ſerved to cover the whole ball of our ſtandard or gaged thermoſcope; and when, after this had ſtood a while in the water to be brought to its temper, we put in the above-mentioned ſalt, the tincted ſpirit of wine manifeſtly ſubſided about two tenth parts of an inch, and probably would have fallen lower, if there had been more water in the veſſel to make a ſeaſonable ſolution of the ſalt, whereof a conſiderable part lay undiſſolved at the bottom.

To the ſame title.

Experiment IV.

WHEN we perceived the liquor to ſubſide no more, we put to it by degrees ſome ſtrong ſpirit of nitre, till it would no longer make any manifeſt conflict with the diſſolved ſalt. The event of which trial was, that the liquor in the thermoſcope began preſently to mount, and continued to do ſo as long as the conflict laſted; at the end of which, we found by meaſure, that it had aſcended more than three inches and a half above the ſtation it reſted at when the ebullition began.

To the ſame title.

Experiment V.

THE figuration of the volatile ſalt of human blood may be conſidered, either in regard of the ſingle grains, or of that aggregate of them, which, when they are made to aſcend to the top of the glaſs, may be called its ſublimate. The latter of theſe may be beſt obſerved, when the ſaline exhalations firſt aſcend and faſten themſelves to the inſide of the blind head, or other glaſs, that is ſet to receive them. For, though towards the end of the operation the corpuſcles lie ſo thick and confuſed, as to leave no diſtinct figures, yet at firſt one may often obſerve the little ſaline concretions to lie in rows, ſometimes ſtrait enough, and ſometimes more or leſs crooked, with differing coherencies and interferings; ſo that though ſometimes theſe rows of concretions may, eſpecially if a little befriended by the ſpectator's fancy, repreſent either trees, or their branches, or hartſhorn, *&c.* yet theſe ſeem not to be conſtant repreſentations depending upon the particular nature of human blood, but caſual figurations, that depend upon ſeveral accidental cauſes and circumſtances, ſuch as the degree of fire employed to ſublime the ſalt, the plenty or paucity of the aſcending matter, the capacity and figure of the veſſel, that receives it, beſides ſeveral others not needful to be here enumerated. Nor is the ſalt of human blood the only volatile one, among whoſe elevated concretions I have obſerved the above-named circumſtances to produce diverſity of configurations. But as to ſingle grains of the volatile ſalt of blood, I diſcerned a good many of them to be finely ſhaped; but whether it were accidental or not, further trial muſt inform me. I could not, that I remember, obſerve theſe handſome figures in the concretions, that compoſed the ſublimate, that was obtained by rectifying or elevating again the ſalt, that firſt came over, but in the grains, that in the firſt diſtillation faſten themſelves to the upper part and ſides of the receiver; for of theſe divers were of conſiderable bigneſs and ſolidity: and though they were not all of the ſame ſhape, ſome of them being not unlike to cubes, others to parallelopipeds, others to octoedrons, being almoſt like grains of allum; yet moſt of them were prettily ſhaped, being comprehended by planes ſmooth, finely figured, and aptly terminating in ſolid angles, as if the concretions had been cut and poliſhed by a jeweller.

To the ſame Title.

Experiment VI.

THERE is another way, that I have uſed to obſerve the figures of the ſalt of blood, which was to rectify the ſpirit of blood, ſo as it may be fully ſatiated with the ſalt, whilſt the liquor (in the receiver) continued yet ſomewhat warm. For then, ſetting aſide this over impregnated liquor when it came to be refrigerated (which ſhould be done very ſlowly) there appeared at the bottom of the vial a good number of ſaline concretions of differing ſizes; ſeveral of which, as far as the reſt would ſuffer me to ſee them, were ſhot into cryſtalline plates, very ſmooth, and prettily figured, having, to the beſt of my conjecture, their broad and parallel ſurfaces of a hexagonal or an octogonal figure regular enough.

To the ſame Title.

Experiment VII.

ACCORDING to the hypotheſis of divers learned naturaliſts and phyſicians, I ſuppoſed it would be thought conſiderable to know, what would happen upon putting together the volatile ſalt of human blood, and the ſpirit of nitre, with the more fugitive parts of which ſalt they conceive the air to be plentifully, and ſome of them to be vitally impregnated.

To gratify ſome of theſe philoſophers, we took a dram of dry volatile ſalt of blood, (which we made choice of, rather than ſpirit, becauſe we had a mind to know what quantity of acid ſalt it would retain;) and having diſſolved it in ſome diſtilled water, we dropped into it good ſpirit of nitre, till the two liquors, though they were ſhaken, would no longer manifeſtly act upon one another: the conflict being ceaſed, we ſlowly evaporated the ſuperfluous moiſture, which ſteamed almoſt all away before the ſaline part would coagulate. At length it came to drineſs, and then the middlemoſt part appeared in the form of thin cryſtals, not unlike thoſe of ſaltpetre; but the reſt, which was by much the greater part of the concretion, ſeemed to be a confuſed maſs without any diſtinct figure. This maſs weighed but 12 gr. more than a drachm. So that, as far as this ſingle experiment can inform us, the volatile ſalt of blood may be ſatiated by ſo little as a fifth part of its weight of the ſaline corpuſcles of ſpirit of nitre. This compounded ſalt being laid in a window, did appear to be very prone to be reſolved by the moiſture of the air, or, in the chymiſt's phraſe, to run *per deliquium*. A little of the ſame ſalt being put upon a well-kindled coal, readily melted, and ſeemed to boil, and towards the latter end made a noiſe, and afforded a flame very like common nitre, ſave that its colour was more yellow. The ſtrong ſmell, that accompanied this deflagration, was like that, which is peculiar to ſpirit of nitre.

To the twenty-firſt Title of the History.

Experiment I.

HUMAN blood, as moſt of the other ſubjects of the animal kingdom, that I have had occaſion to examine, afforded by diſtillation in a retort an empyreumatical and very fetid oil, whoſe colour was almoſt black; but that ſeemed to me to proceed only from the intenſe and opacous redneſs of the liquor, ſince ſome portions of it being purpoſely looked on againſt the light, when they were ſpread very thin upon glaſs, appeared of a deep yellow, or of a reddiſh colour, as they chanced to lie more or leſs thick upon the glaſs.

Experiment II.

When the blood was well dried, before it was committed to diſtillation, I found it to afford a greater quantity of oil, in proportion to the weight of the dry body, than was at firſt expected. Once out of a pound of not over-well dried blood, we had near an ounce and a half of oil; and from another parcel we had it in a far greater proportion to the quantity of blood, that afforded it.

Experiment III.

I remember, that having many years ago had the curioſity to prepare blood by a very convenient digeſtion, and to rectify very carefully the diſtilled liquors, that came over, with the flame of a lamp; I obtained among other things two oils of very differing colours, the one being of a yellow or pale amber colour, and the other of a deep red. But that, which ſurprized even ingenious ſpectators, was, that though theſe oils were both of them afforded by the ſame blood, and were clear and pure enough, yet they would not only ſwim in diſtinct maſſes one over another, but if they were confounded, by being ſhaken together, would little by little ſeparate again, as common oil and water are wont to do. Whether the difference in ſpecific gravity between theſe two oils could keep them from permanently mixing, when they were mingled, as well as it kept their maſſes diſtinct before they were ſhaken; or whether this ſeeming antipathy proceeded from ſome particular incongruity in the textures of theſe liquors, I ſhall not now ſtay to diſpute.

Experiment IV.

It may be of ſome uſe, eſpecially to thoſe, that aim at making medicinal uſes of human blood; to know, that having had a ſuſpicion, that the oil of blood might contain or conceal divers ſaline particles capable of being ſeparated from it; we took a parcel of unrectified oil, and having put to it a convenient quantity of diſtilled water (I ſuppoſe rain-water would have done as well, though common water would not) we diligently confounded theſe liquors by frequent agitation, that the water might rob the oil of its ſeparable ſaline corpuſcles. Of which trial the event was, that after the liquors were well ſettled, the water (whereof we purpoſely forbore to employ too much) was found impregnated with ſaline corpuſcles, that it had by diſſolution obtained from the oil, by virtue of which it was endowed with a moderately briſk taſte, and would readily turn ſyrup of violets green, and precipitate out of a ſolution of common ſublimate a white powder, to name now no other of its reſemblances to weak ſpirit of human blood. And this operation I the more willingly relate on this occaſion, that you may be invited to try, what the like method will do on other empyreumatical oils, as of hartſhorn, urine, *&c.* drawn from bodies, that belong to the animal kingdom.

Experiment V.

To examine a conjecture, whoſe grounds I cannot ſtay to ſet down, we put ſome unrectified oil of human blood into a concave piece of glaſs; and then having dropt into it as much oil of vitriol, as might by gueſs amount to a fourth or third part of the fetid oil, we ſtirred them well together with a ſlender piece of ſolid glaſs; by which means the mixture was made to ſend up good ſtore of whitiſh fumes or ſmoke, and grew, as was expected, conſiderably hot, it being indeed ſo hot, that though it amounted not to above a ſpoonful, yet I was not able, without pain and inconvenience, to hold my finger underneath that part of the glaſs, that contained the incaleſcent liquors.

Experiment VI.

It may be worth while to relate, that what I have elſewhere obſerved about ſome other empyreumatical oils, holds true in that of human blood: for having taken ſome of this liquor unrectified, though in that ſtate it appeared groſs, and dark, and muddy, yet it would readily, even in the cold, diſſolve in, or mingle with highly rectified vinous ſpirits, to which it communicated a reddiſh colour deep enough, agreeably to what I formerly noted touching the colour of this oil.

To the twenty-ſecond Title of the History.

I Do not remember to have met with, in any author, an account of the qualities of the fixed ſalt of human blood; and I know not whether any have had the curioſity to prepare it; whereat I do not much wonder, since to obtain ſo much as ℥j. of it, there is requiſite a conſiderable quantity, perhaps ſome pounds of blood; and the calcination requires ſo obſtinate a fire, that a man's patience may eaſily be tired before the operation be perfected; or by the ſmall appearance of calcination, that the *caput mortuum* will afford him after having been kept three or four hours in the fire, he may be induced to conclude, that all the ſalt of blood is volatile in a good fire, and conſequently, that it will yield no fixed ſalt.

But having by an obſtinate calcination obtained between three and four drachms of this ſalt, I found not, that it was a fixed alcaly or a lixiviate ſalt, but rather, as I expected, of the nature of common or ſea-ſalt, though not without ſome little diverſity, which diſcovered itſelf by ſome nice trials. But as to the main, our ſalt was ſcarce diſtinguiſhable from marine ſalt, for it taſted very like it; a ſtrong ſolution of it did not readily (for I was not at leiſure to wait long for the event) turn ſyrup of violets green or greeniſh, nor (which was more) precipitate a brick colour or browniſh yellow, no more than a white powder, out of ſolution of ſublimate. I alſo found by trial, that the ſpirit of ſalt did not diſſolve it as an alcaly. And to theſe ways of examining it I added three others, that I had not known uſed for ſuch a purpoſe, and which had all three of them ſuch events as were expected: for having put ſome oil of vitriol upon a little of our dry ſalt, it did immediately, as I had divers times obſerved it to do upon common ſalt, corrode it with great violence, and with much foam and ſmoke. We alſo dropped a little of our fixed ſalt, diſſolved in diſtilled water, upon a ſolution of fine ſilver made in *aqua fortis*, whereupon immediately enſued a precipitation of a copious white powder. And laſtly, for further trial, having put ſome leaf gold into *aqua fortis*, which would not (as will eaſily be believed) work upon it; whilſt it was ſwimming there without being ſo much as diſcoloured, I put a little of our powdered ſalt into the liquor, which being thereby turned into a kind of *aqua regia*, did in a trice, without the aſſiſtance of heat, totally diſſolve it.

To the twenty-third TITLE of the HISTORY of HUMAN BLOOD.

THERE is a far greater calcination, than one would expect, required to obtain the *caput mortuum* of human blood, which affords but very little of it. For from ℥xxiv. of dried blood, (which perhaps was but the third or fourth part in weight of the entire blood, that afforded it) we could get after two days calcination but ʒij. 9 gr. of earth. And though this were ſo carefully made, that it may very probably be ſuppoſed to deſerve the name of *terra damnata*, better than moſt ſubſtances, to which chymiſts are wont to give that appellation; yet one may ſuſpect, that this itſelf was not pure elementary earth, ſince it had a red colour, very like that of colcotar of vitriol.

To the twenty-fourth TITLE of the HISTORY.

THE quantities of the principles, or rather of the ſeveral differing ſubſtances, obtained by diſtillation from human blood, may ſeem eaſy, but is indeed very difficult, if at all poſſible, to be determined; not only becauſe of the ſometimes great diſparity, as to proportion, that may be met with of the fibrous, or concreted part, to the ſerum, in the blood of differing perſons, and even of the ſame perſons according to differing circumſtances; but alſo, becauſe it is more difficult to diſtill even the dried and pulverable part of blood without addition, than thoſe, that have not tried, will eaſily judge; and I doubt, that few have tried it well, becauſe I have not met with any, that takes notice of the neceſſity of ſhifting the retort, to gain as much volatile ſuſtance as may be obtained, and leave as little as may be in the *caput mortuum*. For when we diſtilled a ſomewhat conſiderable quantity of dried blood, though it was warily done by an expert artiſt, yet the ſame heat, that made the lower part of the blood paſs in the form of exhalations into the receiver, made the matter ſo ſwell, that it heaved up to the upper part of the veſſel a conſiderable quantity of black matter, which an ordinary diſtiller would have taken and thrown aſide for *caput mortuum*, but which an heedful eye might eaſily diſcern to be much of the ſame nature with what it was, when it was firſt put in, though it were blackened by the aſcending fumes. Wherefore we took it out, and mixing it with the remaining ſubſtance, that was leſs remote from the nature of a true *caput mortuum* it was again in another retort committed to diſtillation, whereby we obtained more oil, &c. And perceiving, that even this ſeeming *caput mortuum* had at the top of it a pretty deal of matter, that I did not think ſufficiently diſpirited, if I may ſo ſpeak, I cauſed it to be taken out, and diſtilled in a freſh retort, in which it afforded a not contemptible quantity of volatile matter.

Having thus prepared you not to expect any thing of accurateneſs, in the determination of the quantities of the differing ſubſtances obtainable even from dried human blood; that I may aſſiſt you to make ſome gueſs at it, that may approach ſomewhat near the truth, I will inform you, that having thus in three retorts diſtilled 24 ounces of dried human blood, we obtained of volatile ſubſtances, I mean ſpirit, together with a little phlegm, white ſalt, and very high coloured oil, ℥xiij. and a drachm, beſides ſeveral parcels of thick oil, that ſtuck to the retorts and the receiver, which we eſtimated at ſeven drachms more. So that the whole volatile part amounted to fourteen ounces, of which we found the oil to be about ℥iij. + ʒvj. And the clear liquor (which, though probably not without ſome phlegm, may deſerve the name of ſpirit, becauſe it was fully ſatiated with ſaline and ſpirituous parts) to be ℥vi + ʒiijſs. beſides the volatile ſalt, which, when the ſpirit was drained from it, appeared white, but wet; for which reaſon it was not poſſible to determine exactly, neither how much liquor it yet retained, nor conſequently how much itſelf weighed; but you may gueſs pretty near the truth, when I ſhall have told you, that having carefully ſublimed the ſalt, there remained in the glaſs ʒij and about five grains of phlegmatic liquor, which was not judged devoid of ſalt, though it could not by that operation be ſeparated; and of volatile ſalt in a dry form we obtained ℥j + ʒijſs. The *caput mortuum* amounted to ℥viijſs, and ſomewhat better, which being calcined for two days together, afforded not white, but only browniſh red aſhes, whence we obtained ʒvij and a quarter of white and fixed, but not truly lixiviate, ſalt; and (as was lately noted to another purpoſe, under the next foregoing title) ʒij, and nine grains of earth. In this troubleſome experiment there occurred ſo many neceſſary operations, in each of which we could ſcarce poſſibly avoid loſing ſome, and now and then a conſiderable portion of the matters we handled, that if you had been preſent at the trials, perhaps you would not think it ſtrange, that I ſhould write, (as I did a little above) that I think it a very difficult thing in practice, to determine exactly the proportions of the differing ſubſtances, that may be chymically obtained, by vulgarly known operations, from a propoſed parcel of human blood; eſpecially ſince I think, that it is without ſufficient grounds, that chymiſts do univerſally take it for granted, that in diſtillations carefully made, the matter, that paſſes into the receiver, or at leaſt aſcends, together with the remains, or *caput mortuum*, amount to juſt the weight, that the entire body had before diſtillation: which paradox I endeavour to make highly probable, if not certain, in another paper, that belongs not to the preſent collection.

Of this ſalt ſee the notes referred to the 22d title.

PART III.

Containing promiſcuous experiments and obſervations about the ſerum of healthy man's blood;

(Whereof the firſt may be referred to the ſixteenth, and moſt of the reſt to the ſeventeenth of the titles of the firſt order.)

SINCE the diviſion, that nature herſelf makes of human blood, when being let out of the veins it is ſuffered to refrigerate and ſettle, is, into a fluid or ſerous, and a conſiſtent or fibrous part; and ſince it is found, that oftentimes the former of theſe parts either equals or exceeds the latter in quantity; I thought it might probably much conduce to the better diſcovery of the nature of the blood, to make ſome trials upon the ſerum by itſelf; of which, it will not, I hope, be uſeleſs to give a ſummary account in the following promiſcuous obſervations, that were made only upon the ſerum or whey of the blood of perſons preſumed to be ſound.

1. HAVING ſeparately weighed the ſerum and the conſiſtent part of a parcel of human blood, obtained at once by a ſingle phlebotomy, we found the latter to weigh ℥iv + ʒvjſs, and the former ℥iij + ʒvj: and having made the like trial with another parcel of blood drawn from another perſon, the fibrous part weighed ℥iv + ʒv and the ſerum four ounces: but though in both theſe trials the weight of ſerum, that appeared in one maſs, was inferior to that of the fibrous part; yet it would not be ſafely inferred, that, abſolutely ſpeaking, the fibrous part of either of theſe parcels of blood exceeded the other, ſince we weighed only the ſerum, that we found in a diſtinct maſs; whereas a multitude of ſerous particles may well be ſuppoſed to be lodged between the parts of the conſiſtent maſs or portion of the blood; ſince, beſides, that it is, probably upon the account of the interſperſed ſeroſity, very ſoft, it affords a great deal of aqueous liquor.

2. THIS may ſufficiently appear by the following experiment, which was purpoſely made to examine this conjecture.

WE took a porringer of blood, wherein the ſerum was ſeparated from the fibrous portion, that was coagulated into one conſiſtent maſs; and having carefully poured off all the fluid part, we put the remaining maſs (which weighed ℥iv. + ʒv + 34 gr.) into a ſmall head and body, and diſtilled it in the digeſtive furnace, till the matter left in the bottom of the cucurbite was quite dry, which it did appear to be long before it was ſo indeed. Then taking out the ſeparated parts of this red maſs, the dried portion was found to weigh but ℥i + ʒiij + 34 gr. whereas the ſerous liquor, that paſſed into the receiver, and was limpid and aqueous without any ſhew of ſalt or oil, amounted to ℥iij + 53 gr.

FOR further ſatisfaction we repeated this experiment with the fibrous part of another parcel of human blood, and found the dry maſs remaining in the cucurbite, to weigh but ℥j + ʒvj + 50 gr. whereas the plegmatick liquor diſtilled from it amounted to ℥vij. that is, to more than three times and a half as much as the dry part.

3. HAVING hydroſtatically examined the ſerum of human blood, we found it heavier than common water: for a piece of red ſealing-wax being ſuſpended in a good balance by a horſe-hair, was found in the air to weigh ʒj + 56 gr. and in the water 35 gr. but did in the ſerum weigh but 33 gr.

THIS trial was confirmed by a more exact one, made with an inſtrument, that I purpoſely cauſed to be made for weighing liquors nicely, in which, when common water weighed 253 grains, an equal bulk of ſerum weighed 302: and becauſe I ſuppoſed, that all ſerums of human blood would not be of equal ſpecific gravity; I thought fit to try that of the blood of another perſon in the ſame inſtrument, and found it to weigh two grains leſs, that is, 300 grains in all.

4. We once employed ſome ſerum, that could not be (or at leaſt was not) poured off ſo clear, but that it appeared of a reddiſh colour; and though we filtered it through cap-paper, yet a good number of the tinging corpuſcles were ſo thoroughly mingled with it, that the liquor paſſed through the filtre of a yellow colour.

5. To try whether acids would coagulate our ſerum, as I had found they would ſome other animal liquors, I dropt into it ſome ſpirit of ſalt, which did immediately produce with it ſome white concretions, that quickly ſubſided to the bottom, and there (when there was a pretty quantity of them) appeared like a very light and tender cheeſe-curd.

The like operation, but more powerful, had oil of vitriol upon another parcel of our ſerum.

6. We dropt into ſome of our liquor good ſpirit of ſal-armoniac; which, as we expected, rather made it more fluid, than did appear to coagulate it, as the acid liquors had done.

7. To try whether theſe precipitations did not more proceed from the coalition and texture of the acid ſalts and the ſerum, than barely from the peculiar action of thoſe ſalts, as acids; we dropt into another portion of our ſerum, a ſtrong alcaliſate ſalt, *viz.* oil of tartar *per deliquium*, which inſtantly produced a white curd, as the ſpirit of ſalt had done, but not, as it ſeemed to us, ſo copiouſly.

8. We poured alſo upon ſome ſerum highly rectified ſpirit of wine, which, as we expected, did preſently coagulate ſome part of it into a white curd, that was copious enough, but appeared much lighter than either of the former, ſince it would not like them ſubſide, but kept at the top of the liquor.

9. To try alſo, what a ſalt compounded with a metal would do upon our ſerum, we put to it a little ſtrong ſolution of ſublimate, with which it preſently afforded a white and curdled ſubſtance.

We put ſome of our ſerum upon ſome filings of *Mars*; but, by reaſon of the colour of the liquor itſelf, we could not ſatisfy ourſelves about the event: and though we afterwards put another parcel of ſerum upon filings of the ſame metal, yet neither did this give us ſatisfaction, in regard the vial having been miſlaid, was not looked upon again till many days after; at which time the liquor was grown ſo thick and muddy, that we could not well diſcern any more of the colour, than that it was ſomewhat dark, but not either black or blackiſh: yet, by a trial or two, that we made with a little of this liquor, it ſeemed to have made a ſolution of ſome part of the ſteel; for putting it to ſome freſh infuſion of galls, made with water, it preſently afforded a copious precipitate; but this was ſo far from being inky, that it was not ſo much as dark coloured, but rather whitiſh; at which ſome analogous experiments (mentioned in another treatiſe) that I formerly made, kept me from wondering. Yet I ſhall not omit to add, on this occaſion, that having mixed with ſome of our impregnated ſerum a convenient quantity of infuſion of galls, made in a highly rectified vinous ſpirit, the two liquors did not only afford a kind of coagulum, or precipitate; but, being left together for ſome hours, aſſociated into a conſiſtent body, wherein the eye diſcovered no diſtinct liquor at all.

10. But expecting more clear ſucceſs, by putting ſome of our liquor upon filings of copper, which, when wrought upon by bodies, that have in them any thing of urinous ſalt, are wont to give a conſpicuous tincture; we accordingly found, that the metal had in a very few hours diſcoloured the menſtruum; and afterwards (the vial being left unſtopped, that the air might have acceſs to the liquor) it began by degrees to grow more and more blue, and within a day after was of a deep ceruleous colour.

11. And, to be confirmed in our conjecture, that this tincture proceeded from ſome particles of volatile ſalt latent in the liquor, we mixed ſome of it with a convenient quantity of ſyrup of violets, and thereby obtained what we looked for; namely, a colour, which, by reaſon of the action of thoſe particles upon the ſyrup, appeared of a fine green.

12. The blue tincture or ſolution of copper (mentioned number the 10th) I thought fit to keep for ſome time, to try, whether the metalline particles would, as it were, embalm the ſerum they were diſperſed thorough, and preſerve the liquor from putrefaction: and in effect, though the vial was left unſtopped in a window in my bed-chamber for many weeks, yet I (whoſe organs of ſmelling are very tender, and who did often put the vial to my noſe) did not perceive the liquor to grow at all ſtinking.

13. About ℥ij, by gueſs, of ſerum of human blood, were left in an unſtopped vial (which they more than half filled) for twenty days or three weeks; and though the glaſs uſually ſtood in a ſouth window, and in the month of *July*, yet, ſomewhat to our wonder, the ſerum did not by the ſmell appear putrified, and yet had let fall a conſiderable quantity of whitiſh ſediment: but within three or four days after this, the liquor was found to ſtink offenſively. Wherefore, we tried, whether this more than incipient putrefaction was accompanied with any acidity; but could not perceive, that it was, ſince it would not ſo much as take off the blue colour of the infuſion of lignum nephriticum, or our ſuccedaneum, to it: when it was in this ſtate, we put it to diſtil in a low cucurbite with a gentle fire, to try, if from this fætid liquor, as is uſual from putrified urine, the ſpirit would firſt aſcend; but we found the liquor, that firſt came over, to be ſo little ſpirituous or ſaline, that it would not in an hour's time turn ſyrup of violets green: but yet we

judged it not quite deſtitute of volatile alcali, becauſe having let fall ſome of it into a good ſolution of ſublimate, it preſently made a white precipitate.

14. WE took ſome ounces of ſerum of humane blood, filtred through cap-paper to free it from all concreted ſubſtance; and having committed it to diſtillation, in a ſmall retort placed in a ſand furnace, we obtained only a few large drops of a darkiſh red oil, ſome of which ſubſided to the bottom of the other liquor, but the greater part ſwam upon it. We obtained in this firſt diſtillation no volatile ſalt in a dry form, but after a pretty deal of inſipid phlegm had been drawn off, there came over a good proportion of ſpirituous liquor, which ſmelled almoſt like the ſpirit of blood, and contained a pretty deal of volatile alcaly; ſo that it would readily turn ſyrup of violets green, and make a white precipitate in the ſolution of ſublimate, and a great ebullition with ſpirit of ſalt: this ſpirit being rectified in a ſmall head and body, there was left, in the bottom of the glaſs, a greater quantity than was expected of a ſubſtance thick like honey, and which was for the moſt part of a dark red, and ſeemed to contain more oil than appeared upon the firſt diſtillation. The liquor, that came over the helm, ſeemed more pure, but not very much ſtronger than the firſt ſpirit. Yet, having put it into a glaſs egg with a ſlender neck, and given the veſſel a convenient ſituation in hot ſand, we obtained a volatile alcali, that ſublimed into the neck in the form of a white ſalt. If this trial be reiterated with a ſucceſs like that I have now recited, it will ſeem to argue, that the ſerous, or fluid part of the blood, affords the ſame elementary principles, or ſimilar ſubſtances, both as to number and kind, that the fibrous and conſiſtent part does, though not as to quantity; that of the oil and dry ſalt being leſs in a determinate portion of ſerum, than they would be in a like quantity or weight of the concreted part of the blood.

HAVING long ſince obſerved, that though the ſpirituous parts of man's urine are wont to require, that the liquor be digeſted or putrified about ſix weeks, to looſen them from the more ſluggiſh parts, and make them aſcend before the phlegm; yet if freſh urine be poured upon a due proportion of quick-lime, a good part of the ſpirit will preſently be untied, and made capable of aſcending in diſtillation; I thought it worth while to try, what would be afforded by the ſerum of human blood, if it were put upon quick-lime, before we diſtilled it. In purſuit of this enquiry, we put theſe two bodies together, upon whoſe commixture there enſued (but not preſently) a ſenſible, but tranſient heat. This compounded body, being committed to diſtillation, afforded firſt a kind of phlegm in a gentle fire, and then in a ſtronger, a moderate quantity of liquor, that was thought to ſmell manifeſtly of the lime, but had not a briſk taſte. This was accompanied with ſomewhat more of high coloured and fœtid oil, than was expected. The other liquor being ſlowly rectified, the ſpirit, that firſt came over, had a ſtrong and piercing ſmell; but leſs rank than that of human blood, drawn the ordinary way. Its taſte alſo was not only quick, but ſomewhat fiery. Being dropt upon ſyrup of violets, it preſently turned it green; with a ſtrong ſolution of ſublimate in water, and another of quickſilver in aqua fortis, it immediately made two white precipitates; and being mingled with ſome good ſpirit of ſea-ſalt, though, upon their being confounded, there appeared a thick, but whitiſh ſmoke, there was not produced any viſible conflict or bubbles, yet the colour of the ſpirit of ſalt, appeared much heightened by this operation. But here I muſt, though not in due place, take notice, that having put the lately mentioned mixture of the ſpirit of ſerum and of ſalt, to evaporate, that we might obſerve, whether it would afford a ſalt much figured like ſal-armoniac, we found, that it did not; but that the colour produced in the mixture, whilſt fluid, was ſo heightened in the concretion we ſpeak of, that it appeared of a blood-red colour; but for the ſhape, it was ſo confuſed, that we could not reduce it to any known kind of ſalt. By all which phœnomena, this ſpirit of the ſerous part of blood ſeems to be very near of kin to that of the concreted part of blood, elſewhere by us deſcribed. Becauſe quick-lime is wont to be ſuſpected by phyſicians, by reaſon of its cauſtick and fretting quality, I thought fit to try, whether the fixed ſalt of pot-aſhes (which is a lixiviate alcali as well as lime) being ſubſtituted in the room of it, would in diſtillation have the ſame effect upon ſerum of human blood. Wherefore, to four parts of the liquor we put one of the ſalt, and having diſtilled them ſlowly in a glaſs head and body, we obtained good ſtore of a liquor, which was not judged any thing near ſo ſtrong, as that formerly mentioned to have been drawn off from quick lime: and having put this weak liquor, afforded by our ſerum, to rectify with a gentle heat, we found, that even the two ſpoonfuls of liquor, that firſt aſcended, were not ſpirituous, but very phlegmatick; nor would it well turn ſyrup of violets green, though it afforded ſome little and light precipitate, when it was put upon a ſolution of ſublimate.

THIS may ſeem ſomewhat the more remarkable, if I add, on this occaſion, an experiment, that may be ſometimes of practical uſe, eſpecially in phyſick, and may afford much light to thoſe that are ſtudious, to know the nature and preparations of ſo very uſeful a ſubject, as human urine. We took three parts of freſh urine, (that was not many hours old) and having put into it one part of ſalt of pot-aſhes, (becauſe that was at hand, for elſe I preſume the fixt ſalt of tartar, or even of common wood-aſhes, would have ſerved the turn) and having ſlowly diſtilled them in a head and body, there firſt aſcended a liquor ſpirituous enough; which being ſet aſide, we continued the diſtillation (after having poured the mixture into a retort) till the remains appeared dry. In this operation it is to be noted, that we obtained not one drop of oil, and that (perhaps for that reaſon) this ſpirit of urine was not near ſo fætid, as, being made the common way, it is wont to be: and that the liquor, that came over toward the latter end of the diſtillation, was ſo unlike that, which the ſerum of blood afforded us, that it was not only conſiderably ſtrong, and manifeſtly ſtronger than that, which firſt aſcended, but had a penetrating and fiery taſte, which left a laſting impreſſion upon the tongue; and, with good ſpirit of ſalt, made a notable ebullition, which I remember not, that upon trials purpoſely made, I found the ſpirit of urine, drawn from quick-lime, to have done. And whereas, with this laſt mentioned liquor, I never (that I remember) found any volatile ſalt to aſcend (in a dry form;) in the operation made by the help of ſalt of pot-aſhes, there came up, without rectification, divers grains of volatile ſalt, one of which was chryſtalline, and conſiderably large; ſo that we could, with pleaſure, obſerve it to be like a plate curiouſly figured: but becauſe of ſome leſſer corns of ſalt, that hid one part of it, I could not clearly diſcern, whether it were hexagonal or octogonal.

But here I muſt not conceal, that having, for greater certainty, reiterated this experiment, it had not ſo good ſucceſs; the liquor, that came over, appearing much more phlegmatick than that, which the former trial afforded us; though we both times employed ſalt of pot-aſhes taken out of the ſame veſſel, and the urine of the ſame perſon. So that what the reaſon of the difference may be, does not yet occur to me; but perhaps will, upon further trials: yet this liquor, that appeared ſo weak at its firſt coming over, being rectified *per ſe*, afforded more than was expected of a briſk ſaline ſpirit, from which we eaſily obtained a pretty quantity (in proportion to the liquor) of volatile ſalt in a dry form, and of a very white colour.

We took between two and three ounces of ſerum of human blood; and having put it into a bolthead, capable, by our gueſs, of containing about four times as much liquor, and having ſealed the glaſs hermetically, ſet it by, as well to obſerve, whether any manifeſt changes would appear in it within a week or two, (of which none in that time occurred to us) as for ſome other purpoſes, that may be gueſſed at by the following account of the event.

1. After we had kept the liquor ſealed up above a whole year, it did not appear to be at all coagulated, nor to have let fall any manifeſt reſidence; but ſeemed to be as fluid as when it was firſt put in.

2. It did not appear to have bred any the leaſt worm or maggot. And this I the rather take notice of, becauſe it agrees very well with what I have elſewhere alledged, in diſfavour of their opinion, that think all the fluid and ſoft parts of human bodies do naturally, and of themſelves, in no long time, breed worms, or ſome ſuch inſects; which, for my part, I never obſerved to be generated in blood itſelf, though very long kept and putrified, provided it were freſh enough when put into the glaſs, and, by an exact cloſure, kept from being any way blown upon by flies, or impregnated by ſeminal particles, that may be unſuſpectedly conveyed to it by the air.

3. Nor did there appear to the eye any mother, as they call it, or recrementitious ſubſtance, that is ſuppoſed, in liquors, always to accompany and betoken putrefaction.

4. One of my deſigns, in our experiment, being to try, whether the ſerum would, by the mutual action of the parts upon one another, or by that of ſome catholick permeating fluid, afford ſo much air, as would either crack, or more violently break the glaſs; the tip, at which the bolt-head was ſealed, was warily taken off with a key, whereupon there ruſhed out a pretty deal of air, with a conſiderable noiſe: and I doubted not that this generated (or at leaſt extricated) air had been conſiderably compreſſed, whilſt it was pent up; when caſting my eyes on the liquor, to diſcover what change this eruption had made there, I perceived, on the upper ſurface of the liquor, a multitude of ſmall bubbles, ſuch as are wont to be ſeen in drink a little bottled, upon the opening of the veſſel; and alſo in divers liquors, after the air has been pent up with them, when the glaſſes come to be unſtopped. And I alſo the leſs wondered at this, becauſe I remembered what formerly happened to me, after having ſealed up ſome ſheep's blood, and kept it for ſeveral days in a gentle warmth; for, though the glaſs it was incloſed in, were far larger than this, that contained our ſerum; yet, after ſome time, when no body offered any violence to it, or was near enough to ſtir it, it was ſuddenly blown up with a ſurpriſing noiſe, by the aereal or elaſtical corpuſcles, that were produced, or ſet free by the putrefaction we diſcovered to have been made.

5. The ſmell of our ſerum was ſtrong, but not cadaverous, but rather reſembled that of the tincture of ſulphur, made with ſalt of tartar and ſpirit of wine, or of ſome ſuch ſulphureous preparation.

6. One of the chief aims I had in keeping our ſerum ſo long ſealed up, was to try, whether by a digeſtion, or putrefaction for ſome months, the ſerum of blood would, like urine, (which is commonly thought to be a liquor made of it, and of very near cognation to it) afford a ſaline ſpirit, or an alcali volatile enough to aſcend before the phlegm. And, in purſuit of this enquiry, we committed our ſerum to diſtillation in a ſmall glaſs head and body, and in a digeſtive furnace, being careful to take the firſt ſpoonful, or thereabouts, of ſpirit, that paſſed into the re-

ceiver: but we found, that, though this liquor at firſt ſmelt ſtrong enough, (I ſay at firſt, becauſe the odour ſoon after grew fainter) yet the taſte was not at all briſk nor ſpirituous, like that wont to be obtained by diſtillation from putrified urine; nor did our liquor, being dropped into a little ſyrup of violets, give it preſently any manifeſt greenneſs. But yet, becauſe I found it not inſipid, I thought fit to examine it a little more critically, and dropt a convenient quantity of it into a clear and ſtaturate ſolution of ſublimate in common water, by which means there was produced a whiteneſs like that (but not near ſo denſe) which ſpirit of urine, or volatile ſalt would have produced. And by this I was invited to mix ſome of it with a little ſyrup of violets, upon a piece of white paper, and alſo to wet with the ſame (diſtilled) liquor ſome ſmall fillings of copper ſpread upon another piece of paper, and to leave them both all night in the open air, that the liquor might have time enough to work upon the ſyrup and the metal: by which courſe we found, in the morning, that the former was turned green, and the latter was ſo far diſſolved, as to leave a large blueiſh ſtain upon the paper. I mention theſe things the rather, becauſe, according to the opinion of ſome learned men, this degenerated ſerum ſhould have been of an acid, not an alcaliſate nature.

7. The near cognation, that, according to ſome learned phyſicians, there is between milk, and the more ſerous part of the blood, invited me to try, whether, (according to an experiment made on new milk, that I have heard aſcribed to the famous *Sylvius*) our ſerum of human blood would grow red, by being kept continually ſtirring over a moderate heat, with a competent quantity of ſalt of tartar; but in two trials, we found not any redneſs produced, though one of them was made in a veſſel of refined ſilver, with an eighth part of the ſalt in reference to the ſerum, which was the ſame proportion, that we had uſed, when we made the experiment ſucceed well in milk.

8. Perhaps it will be needleſs to take notice, that the ſerum of human blood will, by heat, be in a ſhort time coagulated into a kind of gelly, or rather, as far as I have obſerved, into a ſubſtance like a cuſtard, as to conſiſtence, though not as to colour. And therefore I ſhall now add, that having found, that acid ſpirits alſo would coagulate ſerum, I thought fit to try, whether alcalies would not oppoſe, or retard its coagulation. Of which trial the event was, that having put ſpirit of human blood to a convenient quantity of ſerum, and cauſed them to be kept ſtirring over a very gentle fire; though the volatile alcali did not hinder the coagulation, yet it ſeemed to make it both more ſlow, and more ſoft or lax: and this effect was yet more conſiderable, when we tried another parcel of ſerum with ſalt of tartar, inſtead of ſpirit of blood.

PART IV.

Containing the hiſtory of the ſpirit of human blood, begun in an epiſtolary diſcourſe to the very learned Dr. J. L.

SIR,

HAVING, by want of leiſure and opportunity, been reduced to treat of the hiſtory of human blood in ſo imperfect and deſultory a way, that ſeveral of the titles have been left wholly untouched, and others have been but tranſiently and jejunely treated of; I thought fit to handle more fully ſome one of the primary titles, and branch it into its ſeveral ſubordinate or ſecundary titles: and for this purpoſe I pitched upon the ſpirit of human blood, being willing, on ſo noble a ſubject, to give a ſpecimen of what might have been done to illuſtrate the other primary titles, if ſome requiſites had not been wanting. And ſince the ſpirit of human blood is, at leaſt, one of the nobleſt of urinous or volatile alcalies, ſo that moſt of the things, that ſhall be taught concerning that, may, with ſome little variation, be applied to ſpirit of urine, hartſhorn, ſal-armoniac, ſoot, *&c.* I thought fit to lay down a ſcheme of ſubordinate titles, whoſe heads (which amount to above half the number of the primary ones, that belong to the whole hiſtory of blood) ſhould be ſo numerous and comprehenſive, that this paper may paſs not only for an example, but for a kind of ſummary of the hiſtory of volatile ſalts in general, and ſo ſupply the loſs of a paper, that I once begun on that ſubject.

And now I ſhould, without further preamble, proceed to the intended hiſtory, but that I think it requiſite to premiſe three or four ſhort advertiſements: whereof the firſt ſhall be, that the ſpirit I employed in making the following trials and obſervations, was drawn from human blood without any ſand, clay, or other additament, (ſave perhaps, that, by a miſtake, that could do no miſchief, a ſmall parcel had ſome vinous ſpirit put to it to preſerve it a while) and that the firſt diſtillations (which I ſo call to diſtinguiſh them from rectifications) were performed in retorts placed in ſand, (and not with a naked fire) care being taken, that the veſſels were not too much filled, becauſe blood [*N. B.*] if it be not well dried, is apt to ſwell much, and paſs into the neck of the retort, if not into the receiver.

Secondly, I deſire to give notice, that the blood we made uſe of, was drawn from perſons, that parted with it out of cuſtom, or for prevention; which was the main reaſon, why I was ſo ſcantily furniſhed with blood, that of ſound perſons being, in the place I reſided in, very difficult to be procured in quantity, and that of ſick perſons being unfit for my purpoſe.

Thirdly, It may not be amiſs, for obviating of ſome ſcruples, to advertiſe, that there being ſo great a cognation between the ſpirit and volatile ſalt of human blood, that, as we ſhall ſee anon, it is probable, that the latter is little other than the ſpirit in a dry form, and the former than the ſalt united with phlegm enough to give it a liquid form; it is preſumed, that it may be allowable to conſider the volatile ſalt of blood as its dry ſpirit.

Laſtly, To the three foregoing it will be fit to add this fourth advertiſement, that though, in compariſon of the particulars thrown in to the ſecond and third part of thoſe memoirs, the enſuing fourth part is methodically written; yet you are not to expect to find in the method any thing of accurateneſs; ſince the experiments and obſervations, whereof this fourth part conſiſts, were written in looſe papers at diſtant times and on differing occaſions; and, becauſe of this and of my haſte, will be found, without any regular dependence or connexion, referred to the titles, under which they are ranged, in that order, or rather diſorder, wherein they chanced to come to hand.

A LIST of the ſecondary TITLES concerning the SPIRIT of HUMAN BLOOD.

a.
1. WHETHER human blood may be ſo ordered by fermentation or putrefaction, as that, in diſtillation, a ſpirit, either urinous or vinous, may aſcend before the phlegm?

b.
2. WHETHER ſpirit of human blood be really any thing but the volatile ſalt and phlegm well commixed?

c.
3. OF the ſpecies of ſaline bodies, to which ſpirit of human blood is to be referred.

d.
4. WHETHER ſpirit of human blood be differing from ſpirit of urine, and other ſpirits, that are called volatile alcalies?

e.
5. OF the quantity of ſpirit contained in human blood: whether accompanied with its ſerum or dried?

f.
6. OF the ſpecifick gravity of ſpirit of human blood.

g.
7. OF the odour, taſte, colour, tranſparence and conſiſtence of the ſpirit of human blood.

h.
8. OF the diſſolutive power of the ſpirit of human blood.

i.
9. OF the tinctures, that may be drawn with ſpirit of human blood.

k.
10. OF the coagulating power of the ſpirit of human blood.

l.
11. OF the precipitating power of the ſpirit of human blood.

m.
12. OF the affinity between ſpirit of human blood and ſome chymical oils and vinous ſpirits.

n.
13. OF the relation between ſpirit of human blood and the air.

o.
14. OF the hoſtility of the ſpirit of human blood with acids, whether they be in the form of liquors or of fumes.

p.
15. OF the medicinal vertues of ſpirit of human blood outwardly applied.

q.
16. OF the medicinal vertues of ſpirit of human blood inwardly uſed in pleuriſies, head-achs, coughs, fevers, ſcurvies, cachexies, dropſies, fits of the mother, &c.

App. AN appendix, containing Paralipomena, and promiſcuous experiments and obſervations concerning the ſpirit of human blood.

The firſt (ſecondary) TITLE.

Whether human blood may be ſo ordered by fermentation or putrefaction, as that, in diſtillation, a ſpirit, either urinous or vinous, may aſcend before the phlegm?

IT is not unlike, that you will think the queſtion propoſed in this title more curious than neceſſary; and I ſhall not quarrel with you, if you do ſo. But that you may not think it groundleſs, I deſire two things may be conſidered; firſt, how ordinary it is, eſpecially ſince the learned Dr. *Willis*'s writings came to be applauded, to look upon fevers as inordinate fermentations of the blood: and the ſecond, that though human urine, which has a great cognation with the human blood, will not, whilſt freſh, afford by diſtillation a ſpirit or volatile ſalt, till the phlegm be firſt drawn off, and then requires a good fire to make it riſe; yet, if it be kept for a competent time (which uſually amounts to divers weeks) in fermentation, (as chymiſts commonly call that, which, in this caſe, I would rather ſtile putrefaction,) the ſpirit and volatile ſalt will with a gentle fire aſcend, before much, if not before any phlegm.

THESE two conſiderations, as I was intimating, may keep that from being thought a groundleſs queſtion, which has been above propoſed. And, though I more incline to the negative than to the affirmative, at leaſt as to the firſt part or member of the queſtion, yet I thought it well deſerved to be determined, if it may be, by experiment; but for want of a ſufficient quantity of blood, and good luck in making trials with that I could procure, I muſt ſuſpend my judgment, till further experience reſolve me one way or other. By what I have yet tried, I am not much encouraged to expect from human blood a vinous or ardent ſpirit, though that be the uſual product of fermentation in liquors: and I am the leſs encouraged to expect this, becauſe I am not ſure, that there is any fermentation, truly and properly ſo called, in human blood, either within or out of the body; having never yet found any thing in the blood or urine, that convinced me, that either of thoſe liquors would afford an ardent ſpirit. I remember I once kept human blood for a year together in a glaſs very carefully, and, if I miſtake not, hermetically cloſed, with a purpoſe to try, whether any ſpirits would firſt aſcend: but when the blood came to be expoſed to the contact of the air, the ſtink was ſo great and offenſive, eſpecially to ſome ladies, that lived in the houſe, that we were fain to have it haſtily thrown away. Another time, having cauſed ſome ſheep's blood to be digeſted in a pretty large vial, hermetically ſealed, after it had continued a good while in the digeſtive furnace, upon a ſudden, though no body touched it, it broke with a ſurprizing noiſe, and blew off the long neck of the vial. Two or three almoſt like miſchances I had with attempts made on human blood, which I was the more troubled at, becauſe I thought it not very improbable, that by putrefaction the texture of blood, like that of urine, may be ſo looſened or otherwiſe altered, that a volatile ſalt or ſpirit may, in a ſlow diſtillation, aſcend before the phlegm. But, as I ſaid before, it is only from further experience, that I muſt expect ſatisfaction in theſe enquiries.

Yet in the mean time I ſhall add on this occaſion, that the ill ſucceſs I had in my attempts to draw a ſpirit from entire portions of blood, without ſeparating any part from it, or adding any foreign body to it, did not hinder, but rather invite, me to try, whether I could not make ſome experiment, of affinity to thoſe above-mentioned, upon whoſe ſucceſs I might ground ſome kind of conjecture, what would have been the events of thoſe trials in caſe they had not miſcarried. Wherefore looking upon the ſerum of blood as the likelieſt part of it, as well as much more likely than the entire blood, to concur to a fermentation properly ſo called; we took ſome ounces of this ſerum, and put to it about a fourth part of raiſins (of the ſun) well bruiſed, and kept them in a glaſs, whereof a conſiderable part was left empty; and having cloſed the veſſel, we kept it in a warm room for many days. The event of this trial was, that within few days the raiſins began to emerge, and afterwards continued to float; and there was produced or extricated a conſiderable quantity of permanent and ſpringy air, as, by a certain contrivance deſcribed in another paper, did manifeſtly appear: both which phænomena ſeemed plainly to argue, that there had been ſome degree of fermentation produced in the mixture. But yet when we came to diſtill the thus altered ſerum, though it did not ſtink, as if it had putrified it would have done, yet the liquor, that firſt aſcended, even with a gentle heat, did not taſte or ſmell like a vinous ſpirit, though it was differing from meer phlegm. If I had been furniſhed with a greater quantity of ſerum, perhaps the reiterated experiment would have given more ſatisfaction; and, in making it, I would have been careful to obſerve, whether the produced fermentation might not be ſuſpected to proceed, not ſo much from the whole ſerum, as ſuch, as from the aqueous particles, in diſtinction from the others, that concurred with them to compoſe it.

As for the ſecond queſtion intimated in this preſent firſt title, namely, whether blood will, by digeſtion or putrefaction, be ſo opened, as that, when it is diſtilled, the ſpirit will aſcend before the phlegm? I likewiſe endeavoured to try that, with the ſerous part of the blood poured off from the fibrous or coagulated, as ſuppoſing it in this ſeparated ſtate more proper for our trial than the entire blood: and having kept a pretty quantity of this ſerum above four times as long, as I had obſerved to have been ſufficient to make urine in diſtillation part with its ſpirit before its phlegm, we diſtilled this long kept liquor with a very gentle fire, that few, or none, beſides the fugitive parts might at firſt aſcend. But we found the liquor, that came over, to have but little ſtrength, either as to ſmell or taſte, nor would it readily turn ſyrup of violets green: I ſay readily, becauſe after they had been ſome hours together it would; but yet as a volatile alcali, it would preſently turn a ſtrong ſolution, made of common ſublimate in fair water, into a white opacous, and almoſt milky liquor.

The ſecond (ſecondary) Title.

Whether ſpirit of human blood be really any thing but the volatile ſalt and phlegm well commixed?

SINCE the queſtion moved in this title may be alſo propounded concerning other alcaliſate ſpirits, as thoſe of urine, hartſhorn, ſoot, &c. it is upon that account the more important: and for this reaſon, as well as for the difficulty of determining it by cogent proofs, I may think myſelf obliged to forbear taking upon me to decide it peremptorily, till further experience ſhall have furniſhed me with fuller information. So that for the preſent, about this difficult queſtion, I ſhall venture to ſay no more than this; that what has hitherto occurred to me, inclines me to think, that the ſpirit of human blood is totally compoſed of volatile ſalt and phlegm; if by phlegm we underſtand, not ſimple or elementary water, but a liquor, that, although it paſs among chymiſts for phlegm, and deſerves that name better than any other liquor afforded by human blood, yet in the ſtricteſt acceptation it is not that; for when the ſpirit, volatile ſalt, and oil, are ſeparated from it by diſtillation and ſublimation, as far as they are wont to be in chymical preparations of volatile alcalies, the remaining liquor, which paſſes for phlegm, will yet be impregnated with ſome particles of oil, and perhaps alſo with ſome few of volatile ſalt, that are too minute to be diſtinguiſhable by the naked eye. But whether frequent rectifications may ſo accurately ſeparate theſe heterogeneous parts, as perfectly to free the aqueous ones from them, and thereby reduce the phlegm to ſimple or elementary water, I am content, at leaſt till I ſhall have had ſufficient quantities of diſtilled blood for making the requiſite trials, to leave as a problem: and this the rather, becauſe I am not ſure, but that, by frequent diſtillations, ſome particles of the fire may, from time to time, ſubſtantially be aſſociated with thoſe of the liquor; nor yet, but that, even in the firſt diſtillation of human blood, the fire may have either ſeparated or produced a liquor, that, though almoſt ſtrengthleſs, and not juſtly referrible to either of the received principles or ingredients, oil, ſalt and earth, is not yet phlegm truly ſo called, but a liquor as yet anonymous; as I have elſewhere ſhewn, that woods, and many other bodies, afford by diſtillation a liquor, that is not an oil, and is neither acid nor alcaliſate, and yet is no true phlegm, but, as I have there ſtiled it, an adiaphorous ſpirit.

It will probably be thought material, if on this occaſion I add, in favour of the opinion or conjecture, to which I lately owned myſelf inclined, that conſidering, that the knowledge of the compoſition of a body may be ſometimes as well, if not better, inveſtigated by the way of generating or producing of it, as by that of analyſing or reſolving it; I made for trial's ſake the following experiment. We diſſolved in diſtilled water as much volatile ſalt of human blood, as the liquor would take up; and then having carefully diſtilled it in a conveniently ſhaped veſſel, with a regulated degree of heat, the diſtillation afforded us ſuch a liquor as was deſired; namely, one, that by ſmell, taſte, and divers operations, appeared to be a good briſk ſpirit of human blood. This experiment, for the main, was made another time with the like ſucceſs.

The third (ſecondary) Title.

Of the ſpecies of ſaline bodies, to which the ſpirit of human blood is to be referred.

I Need not ſpend much time to declare a thing, that is now ſo well known to many phyſicians and chymiſts, of this, and ſome of the neighbouring countries, as it is, that, of late years, ſaline ſpirits, obtained by diſtillation, have been obſerved to be of two ſorts: but becauſe there are many, even of the learned, eſpecially in the remoter parts of *Europe*, that are not well acquainted with this diſtinction; leſt ſome, to whom you may ſhew this paper, ſhould chance to be of that number, it may not be amiſs to intimate in two or three words, that the ſaline ſpirits, that aſcend in diſtillation, are ſome of them acid in taſte, as ſpirit of nitre, ſpirit of vitriol, *&c.* and ſome others have taſtes very differing from that, being rather ſomewhat like common ſalt, or like lixiviate ſalts. And the difference is greater in their operations, than in their taſtes; for being put together, there will preſently enſue a manifeſt conflict between them, and uſually (for I have not found it to hold in all caſes) the one will precipitate the bodies, that the other hath diſſolved. And it is neceſſary to add, that among the ſalts called alcalies, ſome are fixed in conſiderable degrees of fire, and others not; for which reaſon, divers modern ſpagyriſts and phyſicians, that take acid and alcali for the true principles of mixed bodies, call the one fixed and the other volatile alcalies. And, though I have elſewhere queſtioned this doctrine, and given my reaſons, why I approve neither it nor the appellations newly mentioned, and often call the ſalts, made by combuſtion, ſimply alcalies or elſe lixiviate ſalts, and thoſe, that aſcend, ſometimes urinous, and ſometimes volatile ſalts and ſpirits; yet, ſince the names of fixt alcalies and volatile ones are much now in requeſt, I ſhall comply with cuſtom, and oftentimes (though not always) make uſe of them in the ſenſe of thoſe, that employ them.

These things being premiſed, I may now ſeaſonably propound this important queſtion; to what ſpecies of ſaline bodies the ſpirit of human blood is to be referred? I ſay, of ſaline bodies, becauſe, though the ſpirit of blood be a liquor, yet its more efficacious operations ſeem almoſt (if not more than almoſt) totally to depend upon the fugitive ſalt wherewith it abounds. The ground of the foregoing queſtion may be twofold; the one, that I have elſewhere proved againſt the general ſuppoſition, that ſome volatile ſalts, that ariſe even in a dry form, may not be of an alcaliſate, but acid nature; and the other, that not only *Helmont* and his diſciples, but a great part of the modern chymiſts, and phyſicians too, aſcribe digeſtion to an acid ferment or menſtruum in the ſtomach; whence, one may ſuſpect, that ſtore of acid corpuſcles may paſs into the maſs of blood, and impregnate it, as I elſewhere ſhew, that particles of differing natures may be even by the ſenſes diſcovered to do.

But, notwithſtanding this, I ſhall not ſcruple to ſay, in anſwer to the propounded queſtion, that, as far as I have hitherto been able to obſerve, the ſpirit of human blood is manifeſtly referrible to that claſſis, that many call volatile alcalies (and I often call urinous ſpirits;) for I find ſpirit of blood capable of doing thoſe things, the performance of which has been looked on, almoſt ever ſince I publickly propoſed them, as the touchſtone to know volatile alcalies, and diſtinguiſh them from the other ſorts of ſaline bodies. For the ſpirit of human blood will make a great conflict with divers acid ſpirits, as ſpirit of ſalt, *aqua fortis*, *&c.* It will immediately turn ſyrup of violets from its blue colour into a fair green; it will precipitate a ſolution of ſublimate in common water into a white powder; and, in ſhort, I found it to perform thoſe other things, that may be expected from volatile alcalies, as ſuch, as often as I had occaſion to make trial of it, ſometimes on one body, and ſometimes on another.

If I were ſure (as for reaſons elſewhere declared I am not) that the digeſtion of aliments were made by an acid ferment or juice, whenceſoever the ſtomach is furniſhed with it, I ſhould be prone to ſuſpect, that ſome acid particles may be mingled with the blood: but, however, that would not hinder me from referring the ſpirit of human blood to volatile alcalies; becauſe ſo few acid particles would be either deſtroyed by the alcaliſate ones, that are ſo abundant in the ſpirit, or at leaſt theſe would be ſo very much predominant, as to allow us very warrantably to give on their account a denomination to the mixture. As if a few drops of ſpirit of vinegar were mixed with ſome pints or pounds of ſtale urine, they would either be deprived of their acidity by ſome corpuſcles of a contrary nature, that they would meet with in the liquor; or they would be ſo obſcured and overpowered by the fugitive ſalts it abounds with, that the acetous corpuſcles would not hinder the ſpirituous liquor, drawn from the mixture by diſtillation, to be juſtly referrible to the claſſis of volatile, urinous ſalts.

The fourth (ſecondary) Title.

Whether ſpirit of human blood be differing from ſpirit of urine, and other ſpirits, that are called volatile alcalies?

The queſtion, whether there be any difference between the ſpirit of human blood, and other volatile alcalies, as ſpirit of urine, harts-horn, *&c?* Seems to me very difficult to be decided; becauſe two bodies may agree in many qualities, and perhaps, in all of thoſe, that are the moſt obvious, and yet may on ſome third body, or in ſome caſes, manifeſt diſtinct powers, and have their peculiar operations. Nor do I yet ſee any certain way, by which the affirmative part of the queſtion, though it ſhould be true, can be clearly demonſtrated. Therefore, leaving the peremptory deciſion of this queſtion to thoſe, that ſhall think themſelves qualified to make it, I ſhall (at leaſt till I be further informed) content myſelf to make a couple of remarks, in reference to the propoſed inquiry.

And firſt, I think, there may be a great difference between volatile ſalts or ſpirits, as they are ordinarily prepared for medicinal uſes, and as they may, by reiterated rectifications, and other ways of depuration, be brought to as great a ſimplicity or purity, as a dextrous chymiſt can bring them to. I thus expreſs myſelf, becauſe as to an exquiſite or elementary ſimplicity, though ſome eminent artiſts pretend to it, I am not ſure, that chymiſts can attain it; eſpecially conſidering what I elſewhere ſhew of the unheeded commixtures, that may (at leaſt ſometimes) be made by the corpuſcles of the fire, with thoſe of the bodies it works on.

My other remark is, that whether or no, if the ſpirit of human blood, and other liquors abounding like it in volatile alcalies, were reduced to as great a purity as they can by art be brought to, they would be altogether alike in their nature and qualities; yet, if we conſider them (as men uſe to do) in that ſtate, wherein they are wont to be thought pure enough for medicinal uſes, and are accordingly employed by phyſicians and chymiſts; I think it very probable, that there is ſome difference between the ſpirit of human blood and ſome other volatile alcalies, and particularly thoſe afforded by urine and by harts-horn. For, though to me the bad ſmells of all theſe liquors ſeemed to be much alike, yet divers ladies, and thoſe of very differing ages, affirm they find a manifeſt difference between theſe ſmells, and do abhor the odour of ſpirit of blood as a ſtink, though they will with pleaſure hold their noſes a great while over the ſpirit of harts-horn, and even that of (vulgar or European) ſal-armoniac (which is in effect a ſpirit of man's urine) and affirm themſelves to be much refreſhed by it. And, whereas, with ſpirit of urine or of ſal-armoniac joined in a due proportion with ſpirit of ſalt, I have uſually (as I have long ſince noted in another paper *a*) been able to make a ſalt, that ſhoots into the peculiar figure of ſal-armoniac, which figure is very differing from that of ſea-ſalt, nitre, *&c.* I have ſeldom, if ever, obtained (at leaſt in any quantity) a ſalt of that ſhape, by the commixture of the ſpirit of human blood with that of common ſalt; for, though their ſaline corpuſcles, upon the evaporation of the ſuperfluous moiſture, would coagulate together, yet the concretion ſeemed confuſed, and either all or a great part of it was deſtitute of that neat and diſtinct ſhape, that I had ſeveral times obſerved in concretions made by the mixture of the ſpirit of ſea-ſalt with urinous ſpirits. And, as to the medicinal virtues of ſpirit of blood, though I have not had opportunity to make compariſons experimentally, and therefore ſhall forbear to affirm any thing myſelf; yet, if we credit the famous *Helmont*, there is a conſiderable difference between the ſpirit of human blood and that of human urine, ſince he ſomewhere expreſly notes, (though I remember not the place, nor have his book at hand) that the ſpirit of human blood cures epilepſies, which is a thing the ſpirit of urine will not do.

a The uſefulneſs of experimental philoſophy

The fifth (ſecondary) Title.

Of the quantity of ſpirit contained in human blood, whether accompanied with its ſerum or dried.

It is not eaſy to determine the exact proportion of that liquor, which, when by diſtillation obtained from human blood, the chymiſts call its ſpirit, in reference to the other principles or ingredients, whereof the blood conſiſts. For ſome men's blood may be much more phlegmatic or ſerous than that of others, which itſelf may be more or leſs ſpirituous, according to the complexion, age, ſex, *&c.* of the perſon that bleeds. But, to make ſome eſtimate, that will not probably much recede from what may be ordinarily found, I ſhall inform you, that twelve ounces of healthy human blood afforded us ſeven ounces and a half of phlegm, and conſequently about four ounces and a half of dried ſtuff: and then, I ſhall add, that having committed to diſtillation, in a retort in a ſand furnace, ſeven ounces of well dried (but not ſcorched) blood, we obtained about ſeven drachms, that is, about an eighth part of ſpirit, to which, though it were not rectified, that name may well enough be given; becauſe it was ſo very rich in ſpirituous and ſaline parts, that it left, in the receiver and in the vial I kept it in, a good deal of volatile ſalt undiſſolved, which a phlegmatic liquor would not have done: and if that be admitted for a truth, that was above propoſed as a very likely conjecture; namely, that ſpirit of blood is but ſalt and phlegm united, we may well ſuppoſe, that human blood yields a far greater proportion of ſpirit than this; ſince from the ſeven ounces of dried blood laſt mentioned, we obtained about five drachms of volatile ſalt, which if we had by diſtillations united with a fit quantity of phlegm, would probably have afforded us near two ounces of a liquor deſerving the name of ſpirit.

The ſixth (ſecondary) Title.

Of the conſiſtence and ſpecific gravity of the ſpirit of human blood.

To the conſiſtence of the ſpirit of human blood, taken in the more lax ſenſe of the word conſiſtence, one may refer its ſpecific gravity, (as that is uſually proportionate to the denſity of bodies,) the greater or leſſer degree of fluidity, that belongs to the liquor as a maſs, and the greater or leſſer ſubtilty of the minute parts, whereof it is compoſed, or wherein it abounds.

And as to the firſt of the three attributes, we have noted to be referrible to the conſiſtence of our ſpirit; gravity is a quality, that is ſo radicated, if I may ſo ſpeak, in the nature of viſible fluids or liquors, and does ſo obſtinately accompany them, that I durſt not omit to examine the ſpecific gravity (that is, the gravity in proportion to the bulk) of ſpirit of human blood; though by reaſon of the ſmall quantity I had of it I could not make uſe of the ſame inſtruments, that I was wont to employ in hydroſtatical trials, where I was not ſo ſtinted in the liquor to be examined. But, however, I made a ſhift to make a trial of this kind, by which I found, that a compact body weighing fifty eight grains in the air, and in water ſix grains and three fourth parts, weighed in rectified ſpirit of human blood but five grains and one fourth part: and on this occaſion I ſhall tell you, what I preſume you did not expect, which is, that notwithſtanding the volatility of our ſpirit of blood, I found, that a pretty large piece of amber being put into it, did not, as moſt men would confidently expect, fall to the bottom of the liquor, but kept itſelf floating at the upper part of it, and, if plunged into it, would emerge.

The next quality we referred to the conſiſtence of our ſpirit of blood, is the degree of its fluidity, or, if you pleaſe, its greater or leſſer immunity from tenaciouſneſs or viſcoſity, which ſome modern philoſophers (whoſe opinion needs not here be diſcuſſed) think to belong to all liquors as ſuch. Now, one may be the more inclined to expect a manifeſt degree of tenacity in the ſpirit of human blood; becauſe among many modern chymiſts it paſſes for an alcali, and we know, that divers other alcaliſate liquors, as oil of tartar *per deliquium*, fixed nitre reſolved the ſame way, ſolution of pot-aſhes, *&c.* are ſenſibly unctuous, and but languidly fluid: but yet, I did not obſerve, that ſome rectified ſpirit of human blood, that I purpoſely tried between my fingers, did feel more unctuous than common water. And whereas, thoſe, that ſell brandy, or ſpirit of wine, are wont to ſhake it, till it afford ſome froth, and then, by the ſtay this makes on the ſurface, to judge of the tenacity or tenuity of the liquor, eſteeming that to be the moſt unctuous, whereon the bubbles make the longeſt ſtay, and that the fineſt, on which they ſooneſt diſappear; I thought fit, by the ſame method, to examine ſpirit of human blood, and found, that the froth would laſt very little on the ſurface of it, the bubbles breaking or vaniſhing, almoſt (if not quite) as nimbly, as if the liquor had been good ſpirit of wine. And I likewiſe obſerved, that when I warily let fall ſome of our well rectified ſpirit of blood upon ſome other body, it ſeemed to me, that the ſingle drops were manifeſtly ſmaller, than thoſe of water, and of ſeveral other liquors, would have been: which will be much confirmed by one paſſage of what I have to ſay, about the third quality referrible to the conſiſtence of the ſpirit we treat of.

Because it may be a thing of ſome importance, as well as curioſity, to know, how ſubtil the active parts of ſpirit of human blood are, and how diſpoſed and fitted to diſperſe or diffuſe themſelves through other liquors of convenient textures; to make a viſible diſcovery of this, I bethought myſelf of a method, that having formerly deviſed for ſeveral purpoſes, I thought fitly applicable to my preſent deſign. For having looked upon it as a great defect, that men have lazily contented themſelves to ſay in general, that ſuch a body is of ſubtile, or of very ſubtile parts, without troubling themſelves to find out any way of making more particular and leſs indeterminate eſtimates of that ſubtilty; I was invited to find out and practiſe a way, that might, on divers occaſions, ſomewhat ſupply that defect: but having delivered this eaſy method in another paper, I ſhall forbear to repeat a tedious account of it in this; ſince it may here ſuffice to tell you in ſhort, what will perhaps ſurprize you; namely, that according to the forementioned way, we ſo prepared common water by infuſions made in it without heat, that by putting one ſingle drop of our rectified ſpirit of human blood into ℥iv. + ℈iv. (which make 2000 grains) of the prepared water, and lightly ſhaking the vial, there appeared throughout the liquor a manifeſt colour, whereof no degree at all was diſcernible in it juſt before: which ſufficiently argues a wonderful ſubtilty of parts in the ſpirit we employed; ſince that a ſingle drop of it could diſperſe its corpuſcles, ſo as to diffuſe itſelf through, and mingle with two thouſand times as much water, and yet retain ſo much activity, as to make their preſence not only ſenſible, but conſpicuous, by a manifeſt change of colour they produced. I confeſs, this computation is made upon ſuppoſition, that a drop of water weighs about a grain, and that a drop of our ſpirit of blood was of the ſame weight with a drop of water.

The former ſuppoſition is commonly made; and though I have not found it to be exactly true, but that a drop of water weighed a tantillum more than a grain; yet, that difference is much more than recompenſed by that, which we found between the weight of a drop of water, and the weight of one of ſpirit of human blood. For having, in a very good and carefully adjuſted balance, let fall ten drops of common water, and as many of our rectified ſpirit of human blood, (as judging it a ſafer way to make an eſtimate, by comparing ſo many drops of each liquor than one alone;) we found, as we might well expect, that a drop of this laſt named liquor, as it was manifeſtly leſſer, ſo it was far lighter, than a drop of water, inſomuch, that the whole ten drops did not amount to four grains: ſo that we may ſafely judge the drop of ſpirit to have manifeſtly diffuſed itſelf, and acted upon above 4000 times ſo much water in weight, (and perhaps in bulk too;) ſince indeed the proportion extended a good way towards that of one to 5000, and ſo may be ſaid to be, as that of one to between 4000 and 5000; which, though it may ſeem incredible to thoſe, that are unacquainted with the great ſubtilty of nature and art, in the comminutions they can make of bodies; yet, I can, by repeating the experiment, eaſily convince a doubter in leſs than a quarter of an hour. And this ſubtilty of the parts of blood will appear yet greater, if it be conſidered, (what I think I can evince,) that no contemptible part of the ſingle drop I employed was phlegm, uſeleſs to the change produced, the operation being due to the energy of the ſaline ſpirits of the little drop.

The ſeventh (ſecondary) Title.

Of the odour, taſte, colour, and tranſparence of the ſpirit of human blood.

THOSE qualities, that, in my opinion, more generally than deſervedly are called firſt, do not any of them belong to the ſpirit of human blood, in ſuch manner, as to oblige me to ſay any thing of them in relation to it; and therefore I ſhall content myſelf to have made this tranſient mention of them, to keep it from being thought, that through forgetfulneſs I had overlooked them: yet, ſomething there is, that may not inconveniently be referred to the heat or coldneſs of ſpirit of human blood; in regard that phyſicians, as well as philoſophers, diſtinguiſh theſe qualities into actual and potential; for it ſeems, that the ſpirit of human blood is, in reference to ſome liquors, potentially cold, ſince it refrigerates them; and, in reference to ſome others, potentially hot, ſince, being mingled with them, the mixture becomes actually hot. Of this laſt, I ſhall here ſet down the enſuing inſtance.

Into a ſlender cylindrical glaſs we put the lower part of an hermetically ſealed thermoſcope; which, in this paper and elſewhere, I uſually call the gaged one, becauſe it was adjuſted according to the ſtandard of ſuch inſtruments kept at *Greſham* college. Into this cylindrical glaſs we poured as much moderately ſtrong ſpirit of blood, as would cover the ball of the thermometer, and then dropped on that liquor ſome good ſpirit of ſalt, upon whoſe mingling with it there was produced a conflict, accompanied with noiſe and bubbles, and a heat, which nimbly enough made the ſpirit of wine aſcend two inches and a half. This experiment is therefore the more conſiderable, becauſe there are divers volatile alcalies, that being confounded with acid ſpirits, though they ſeem to make a true efferveſcence, yet do really produce a notable degree of coldneſs. And that, which to me ſeemed conſiderable on this occaſion, was, that whereas I had ſeveral times found by trial, that the ſpirit of verdigreaſe (which ſome call the ſpirit of *Venus*) would with the volatile ſalt of ſal-armoniac, or of urine, produce a ſeeming efferveſcence, but a real coldneſs; this ſpirit of verdigreaſe itſelf, being mixed in the forementioned ſmall cylindrical glaſs, with but moderately ſtrong ſpirit of blood, did not only produce a hiſſing noiſe and ſtore of bubbles, but an actual heat, whereby the ſpirit of wine in the thermoſcope was made quickly to aſcend above an inch and a half, though the liquors employed amounted not both together to two ſpoonfuls.

The eighth (ſecondary) Title.

Of the diſſolutive power of ſpirit of human blood.

It will not only ſerve to manifeſt the ſubtilty and penetrancy of the ſpirit of human blood, but it may be alſo of ſome uſe to phyſicians, if it be made appear by experiments, that this ſpirit is by itſelf not only a good medicine for ſeveral diſeaſes, (as will be hereafter ſhewn,) but may be alſo employed as a menſtruum, to diſſolve ſeveral bodies, and even ſome metalline ones. And becauſe theſe laſt mentioned are the moſt unlikely to be readily diſſoluble, by a ſubſtance belonging to the animal kingdom, as chymiſts ſpeak; I ſhall ſubjoin two trials, that I made to evince this diſſolutive power of the ſpirit of blood.

And firſt, we took crude copper in filings, (which if they be very ſmall, are ſo much the fitter for our purpoſe) and having poured on them ſome highly rectified ſpirit of human blood, we ſhook them together; and in about a quarter of an hour or leſs, perceived the menſtruum to begin to look a little bluiſh, which argued its operation to have already begun: and this colour grew higher and higher, till, after ſome hours, the menſtruum had diſſolved copper enough to make it deeply ceruleous. Some other, and ſomewhat differing trials on the ſame metal, will be met with in their proper place. In the mean time, I ſhall here take notice, that, in ſome circumſtances, the ſpirit of blood has ſuch an operation upon copper, whoſe quickneſs is ſurpriſing: for having made a coined piece of that metal clean and bright, (that no greaſe or foulneſs might hinder the effect of the liquor,) and put a drop or two of our ſpirit upon it, within about half a minute of an hour, (obſerved by a watch, that ſhewed ſeconds) the verge of the moiſtened part of the ſurface appeared bluiſh, and, almoſt preſently after, the reſt of the wetted part acquired a fine azure colour.

We alſo took filings of zink, or (as in the ſhops they call it) ſpelter; and having poured on them very well rectified ſpirit of blood, we obſerved, that even in the cold it quickly began to work manifeſtly, though not vigorouſly: but being aſſiſted with a little heat, it diſſolved the zink briſkly, and not without producing ſtore of bubbles, being alſo a little diſcoloured by the operation. Of this experiment ſome uſe is made in another place, and therefore need not be delivered in this.

On this occaſion I ſhall add, that for curioſity's ſake I took a piece of coagulated blood, but not dried, ſomewhat bigger than a large pea, having a care to take it from the lower part of the lump of blood, that it might be black, the ſuperficial part of fibrous blood, that lies next the air, being uſually red. This clot of blood we put into a ſlender vial of clear glaſs, that the colour might be the better diſcerned; and then poured on it a little rectified ſpirit of human blood, and ſhook the glaſs a little; whereupon, in a trice, the colour of (at leaſt) the ſuperficial part of the blood, was, as I had conjectured, manifeſtly changed, the blackneſs quite diſappearing, and being ſucceeded by a very florid colour, like that of fine ſcarlet. The liquor alſo was tinged, but not with near ſo deep or ſo fair a red; and by the little bubbles, that from time to time paſt out of the clod into it, it ſeemed to work like a menſtruum: and yet, ſoon after coming to look upon this lump of blood again, I found it to have much degenerated from its former colour, to one leſs fair and more dark.

We took alſo another clot of blood like the former, ſave that one part of it, which had lain next the air, was not black; and having, in a vial like the former, poured on it ſome ſpirit of blood, taken out of the ſame vial, whence I took the firſt parcel, the reddiſh colour ſeemed preſently to be much improved, and made more fair, and like true ſcarlet: but the black was not ſo altered, as to be deprived of its blackneſs, but retained a dark and dirty colour. So that this ſecond experiment requires a further trial, when there ſhall be conveniency to make it; and it will the rather deſerve one, becauſe what has been already recited of the operation of the ſpirit upon the two parcels of blood, may ſuggeſt uncommon reflections to ſpeculative wits.

And here, on this occaſion, it will be proper to relate to you, that having a confuſed remembrance, that I had a great while before put up ſome human blood, with a certain quantity of volatile ſpirit, to keep it fluid and preſerve it, without diſtinctly remembering what volatile alcali I had employed; I found among other glaſſes, that had been laid aſide, one bolt-head with a long neck, to which was tied a label, importing, that at ſuch a time twelve drams of of human blood were put up with two drams of ſpirit of human blood. By the date of this paper it appeared, that this blood had been preſerved much above a whole twelve month; and yet it appeared, through the glaſs, of a fine florid colour, and ſeemed to be little leſs than totally fluid. And indeed when we came to open the veſſel, which was carefully ſtopt with a good cork and hard ſealing-wax, we found no ill ſcent or other ſign of putrefaction in the mixture, and but a very ſmall portion of blood lightly clotted at the bottom; the reſt paſſing readily through a rag. So that the ſpirit of human blood ſeems to have a great embalming virtue; ſince it was able ſo long and well to preſerve ſix times its weight of a body ſo apt to concrete and putrify, as human blood is known be, and probably would have preſerved it much longer, if we had thought fit to proſecute the experiment. To this account of our trial I know not whether it will be worth while to add, that having broken it off, that we might diſtill the abovementioned mixture with a very gentle heat; the firſt liquor, that aſcended, was not a ſpirit, but a kind of phlegm, though afterwards there came up, beſides a ſpirituous liquor, a volatile ſalt in a dry form.

On this occaſion I ſhall ſubjoin the following trial, long ſince made with a ſpirit, that I ſuppoſed to have been weaker than that, with which the lately mentioned experiments were made.

In order to a deſign, that need not here be mentioned, I cauſed ſome filings of mars to be purpoſely made, that, being preſently employed, they might not contract any ruſt, whereby the operation of our liquor might be made doubtful. On theſe we poured ſome of our ſpirit, and having kept them together a while in digeſtion, we found, as we expected, that the liquor had wrought on the metal, and produced a conſiderable quantity of a light ſubſtance, in colour almoſt like crocus, but ſomething paler: and we alſo found more than we expected; for there appeared in the liquor good ſtore of thin plates, like a kind of *terra foliata*, (as the chymiſts ſpeak) which, after a very ſlight agitation, being held againſt the ſun-beams, exhibited the colours of the rainbow in ſo vivid a manner, as did not a little delight, as well as ſurpriſe the ſpectators; but I did not perceive, that the taſte of the liquor was conſiderably martial.

The ninth (ſecondary) Title.

Of the tinctures, that may be drawn with ſpirit of human blood.

MOST of thoſe extractions the chymiſts call tinctures, being, as I have elſewhere ſhewn, partial ſolutions of the bodies from which they are obtained, it will, I preſume, be eaſily granted, that ſince the ſpirit of blood is able (as in the foregoing title it has appeared to be) to diſſolve copper and zink, that are ſolid and metaline bodies, it will be able to extract tinctures out of divers others: but, that this power of our *menſtruum* may be rather proved than ſuppoſed, it will not be amiſs to add a few inſtances of it.

Spirit of blood being put upon Engliſh ſaffron, did ſoon acquire upon it a fine yellow colour.

Spirit of blood being put upon powdered *curcuma*, or, as tradeſmen are wont to call it, turmerick, did, in the cold, extract from it a lovely tincture, like a rich ſolution of gold; which probably (to intimate that upon the by) may prove a good de-obſtruent medicine, particularly in the jaundiſe; in which diſeaſe turmerick, that is taken to be a kind of Eaſt Indian ſaffron, is, upon experience, commended, and in this our tincture is united with ſpirit of human blood, which is very near of kin to ſpirit of urine, and probably at leaſt as efficacious; with which liquor, when well rectified, I have had more than ordinary ſucceſs in the jaundiſe.

To make ſome trial of the extracting power of the ſpirit of blood upon ſubſtances, that have belonged to animals, I thought it might particularly conduce to ſome medical purpoſes, to try, what it would do upon the ſolid part of human blood itſelf ſlowly dried, ſo as not to be burned, but only to be reducible, with ſome pains, to fine powder. Accordingly, upon this well-ſifted powder of blood, we put ſome moderately ſtrong ſpirit of the ſame ſubject, on which the liquor began very ſoon to colour itſelf, even in the cold; and within no long time after, it appeared as red as ordinary French claret wine. This extraction made me ſuſpect, that the phlegm, that was not carefully ſeparated from the ſpirit I then employed, might haſten the coloration of the *menſtruum*: for which reaſon I put upon another portion of the ſame powder ſome rectified ſpirit of blood, ſo well dephlegmed, that it would not diſſolve a grain of the volatile ſalt of blood; and I found indeed, as I ſuſpected, that this *menſtruum* did not any thing near ſo ſoon draw a tincture, as the other had done; for after divers hours, the colour it obtained was but brown; but, after ſome hours longer, the colour appeared to be heightened into redneſs, but yet manifeſtly inferior to that of the ſomewhat phlegmatick ſpirit above-mentioned, whereto it did yet, in a longer time, grow almoſt equal. By this means we may not only diſguiſe the ſpirit of blood, but impregnate it with the finer parts of the unanalyſed ſolid body, which may poſſibly make the ſpirit a remedy more proper for ſome diſeaſes or conſtitutions: and this medicine I ſometimes call the intire tincture of human blood, becauſe it conſiſts of nothing elſe but ſuch blood.

To ſhew, at length, that the ſpirit of human blood may extract tinctures out of ſome of the hardeſt bodies, I made the following experiment.

We took ſome choice filings of ſteel (for ſuch are thoſe, that are ſaved by the needle-makers) and having put them into a ſmall egg, we poured on them ſome highly rectified ſpirit of blood, and kept them all night in digeſtion in a moderate heat. The next day (but not early) we found the *menſtruum* turned of a browniſh red colour, that was deep enough. And ſome of the filings, that chanced to ſtick to the ſides of the glaſs, but were higher than the liquor could reach in its groſs body, ſeemed to have been, either by exhalations from the *menſtruum*, or perhaps by the tranſient contact of it, as it was pouring in, turned into a kind of yellow crocus martis. I muſt not here forget, that having kept the *menſtruum* and the filings together in the forementioned egg, for ſome days longer, the colour was grown opacous, and appeared to be black, when it was looked on in any conſiderable bulk; this laſt expreſſion I employ, becauſe it had another appearance, when it was ſomewhat thinly ſpread upon white paper.

Perhaps it may be a remark not altogether uſeleſs to phyſicians, among many of whom chalybeate remedies are in very great requeſt, if I add, that for reaſons not needful to be mentioned here, having a ſuſpicion, that our ſpirit would work upon ſteel, in another manner than the acid ſolvents wont to be uſed by chymiſts and phyſicians; we poured ſome of our tincture, drawn from filings of ſteel, upon a freſhly drawn tincture of galls, (infuſed in common water) and did not find, that this liquor would, with the infuſion, make any inky mixture, nor that the precipitate, that was quickly produced, was of a black, much leſs of a true inky colour; though I have found means to produce, in a trice, a black mixture, with other martial ſolutions and tinctures, which, for curioſity's ſake, I ſometimes made green, ſometimes red, ſometimes yellow, and ſometimes, if I miſtake not, of neither of thoſe colours.

I have been the more expreſs, in ſetting down the particulars above delivered, becauſe, I hope, they may be ſomewhat helpful to rectify the judgment of divers very ingenious modern phyſicians, eſpecially among the cultivaters of chymiſtry, who build much upon a ſuppoſition, which, though I deny not to be ſpecious, I doubt is not ſolid, and I fear may be of ill conſequence. For, by the above recited trials, it may appear, that it is unſafe either to ſuppoſe, that if chalybeates be diſſolved in the body, it muſt be by ſome acid juice; or, to conclude, that if the ſteel be diſſolved by the liquors of the body, it muſt be, *ex prædominio*, (as they ſpeak) alcaliſate; ſince a liquor, that exerciſes a great hoſtility againſt acids, diſſolves it: and, by parity of reaſon, one may probably infer the quite contrary of what they ſuppoſe; in regard that ſteel, in our experiment, was (partially at leaſt) diſſolved by what they call an alcali; and conſequently ought to be, *ex prædominio*, of an acid nature. But of this hypotheſis we elſewhere purpoſely diſcourſe, and therefore ſhall here add nothing concerning it, but leave it to be conſidered, whether it would not be requiſite to ſeek out ſome other way, than phyſicians have hitherto pitched on, to explicate the manner of operation of chalybeate medicines in the human body; and whether ſome uſe may not be made in medicine of martial remedies prepared by volatile alcalies, inſtead of acids.

I put ſome ſpirit of human blood upon powdered amber, ſifted through a fine ſieve, and kept it in digeſtion for ſome days, giving it a pretty degree of heat; but we obtained not hereby any tincture at all conſiderable; whether it was, that the ſpirit was not yet highly enough rectified, or that the amber (which was of a finer ſort of white amber) was not ſo proper to yield its tincture, as I have ſeveral times found courſer, but deeper coloured amber, to be.

To this (ninth) title may be referred the event, that followed, upon our having put ſome ſpirit of human blood upon that ſort of gum *laccæ*, that comes out of the *Eaſt Indies* in grains, and (for that reaſon) is commonly called ſeed-lace: for the ſpirit we put upon this, though this be a reſinous gum, and of no eaſy ſolution, ſoon became tincted; which I expected it ſhould, becauſe I conjectured, that the redneſs, wont to appear in many of the ſeed-like grains, is but ſuperficial, and proceeds from ſome adhering blood of little (winged) inſects, that, by their bitings, occaſion the production of this gum upon the twigs of the tree where the lac is found; on which twigs I have more than once ſeen ſtore of theſe gummous grains. So that the tincture ſeems not to be drawn from the lac itſelf, but rather to be afforded by the blood of theſe little animals, which the ſpirit of human blood, that will draw tinctures from dried man's blood, diſſolves; and this tincture may probably be a good medicine, ſince moſt of the inſects, uſed in phyſick, as *millepedes*, lice, bees, ants, *&c.* even in our colder climates, afford medicines of very ſubtil and piercing parts, and of conſiderable efficacy.

The tenth (ſecondary) Title.

Of the coagulating power of the ſpirit of human blood.

THOUGH the ſpirit of human blood have ſuch a diſſolving power, as we have mentioned, in reference to ſome bodies, yet, upon ſome others, it ſeems to have a quite contrary operation. I ſay *ſeems*, becauſe it may be queſtioned, (and I am not now minded to diſpute it) whether the effect I am going to ſpeak of be a coagulation, properly ſo called, that one body makes of another, or a coalition of particles fitted, when they chance to meet one another, (in a convenient manner) to ſtick together. But whatever name ought to be properly given to the thing I am about to ſpeak of, I have found, by trial purpoſely made, that the highly rectified ſpirit of human blood being well mingled, by ſhaking, with a convenient quantity (which ſhould be at leaſt equal) of vinous ſpirits, that will burn all away, (for if either of the liquors be phlegmatic, the experiment ſucceeds either not at all, or not ſo well) there will preſently enſue a coagulation or concretion, either of the whole mixture, or a great portion of it, into corpuſcles of a ſaline form, that cohering looſly together, make up a maſs, that has conſiſtence enough not to be fluid, though it be very ſoft: and in this form it may remain, as far as I have yet tried, for a good while, perhaps ſeveral months, or weeks at leaſt, if it be kept in a cool place.

The ſpirit of human blood does alſo make a precipitation of dantſick vitriol diſſolved in water, but not, that I have obſerved, a total one; which you need not wonder at, becauſe it will diſſolve copper, which is one of the ingredients of blue vitriol.

The eleventh (ſecondary) Title.

Of the precipitating power of ſpirit of human blood.

Of the precipitating power of ſpirit of human blood, I have yet obſerved nothing, that is peculiar; and therefore it may ſuffice to ſay in general, that, as far as I have had occaſion to try, it has, in common with thoſe other volatile ſpirits, which I elſewhere call urinous, a power of precipitating moſt bodies, that are diſſolved in acid *menſtruums*. I ſay *moſt*, becauſe (as I have elſewhere more fully ſhewn) it is an error, though a vulgar one, to ſuppoſe (as chymiſts and phyſicians are wont to do) that whatever is diſſolved by an acid, will be precipitated by an alcali, as ſuch, whether fixed or volatile, which latter ſort they take the ſpirits of urine, blood, &c. to be of: for there is no neceſſity this rule ſhould hold, when the body is of ſuch a nature, that it may be diſſolved as well by an alcali, as by an acid. And, though the hypotheſis of *alcali* and *acidum* allowed them not to think there were any ſuch bodies, yet I have in another paper experimentally evinced, that there are ſo: and it may be proved, without going very far, ſince we lately obſerved, * that good ſpirit of human blood would, in the cold, diſſolve both copper and zink, which are bodies, that will each of them be readily diſſolved by aqua fortis and ſome other acid menſtruums.

* See the eighth Title.

Bating ſuch bodies as thoſe I have been ſpeaking of, I have not found, but that ſpirit of human blood precipitates other bodies diſſolved in acid menſtruums, much after the ſame manner, that ſpirit of urine and other ſuch volatile alcalies are wont to do. Of this, among other inſtances, I remember, that I made trial upon red-lead, or minium, diſſolved in the acid ſalt of vinegar, ſilver in aqua fortis, gold in aqua regia, and tin diſſolved in an appropriated menſtruum. I alſo, with our ſpirit, precipitated the ſolutions of divers other bodies, which need not here be named. But in regard of the great and frequent uſe, that men make of ſea ſalt, in preſerving and ſeaſoning what they eat, it may not be amiſs particularly to mention, that out of a ſolution of common ſalt, made in common water, we could readily precipitate, with the ſpirit of blood, a ſubſtance, that looked like a white earth; and ſuch a ſubſtance I obtained in far greater quantity from that, which the ſalt-makers call bittern, which uſually remains in their ſalt-pans, after they have taken out as much, or near as much ſalt, as would coagulate in figured grains.

The twelfth (ſecondary) Title.

Of the affinity between ſpirit of human blood, and ſome chymical oils, and vinous ſpirits.

Though in another * paper I declare myſelf, for reaſons there expreſſed, diſſatisfied with the vulgar notions of ſympathy, antipathy, friendſhip, affinity, hoſtility, &c. that are preſumed to be found among inanimate bodies, yet, in this place, nothing forbids to employ the terms affinity, cognation, and hoſtility, in the lax and popular ſenſe, wherein they are uſed, not only by the vulgar, but by ſchool-philoſophers and chymiſts.

* About the mechanical origine, or production of qualities.

It ſeems then, according to this acception of the word affinity, that there is ſuch a thing between rectified ſpirit of human blood and pure ſpirit of wine; ſince we have formerly (under the tenth title) obſerved, that, being put together, they will readily concoagulate, and continue united a long time. It is very probable, that the like aſſociation may be alſo made with other ardent ſpirits prepared by fermentation.

We have likewiſe formerly noted, that our ſpirit will make a ſolution of the finer parts of human blood well dried; which inſtance I mention, on this occaſion, becauſe it ſeems to be the effect of ſome affinity or cognation, (as moſt men would call, what I would call mechanical congruity) between the ſpirit and the body it works on, in regard I found, by more than one trial purpoſely made, that a highly rectified vinous ſpirit (for if it be phlegmatic, the water may diſſolve ſome of the blood) would not (at leaſt in divers hours, that my trials laſted) draw any tincture from it.

With lixiviate liquors, ſuch as are made of ſalt of tartar, fixed nitre, &c. reſolved in the air, or otherwiſe, the chymiſt will expect, that the ſpirit of blood ſhould have an affinity, ſince they eſteem all theſe liquors alcalies, though this be volatile, and thoſe be fixed. But though theſe liquors comport well with one another, yet we find not, that they ſtrictly aſſociate by concoagulation, as we lately obſerved the ſpirit of blood to do with ſpirit of wine.

The ſame ſpirit of blood mingles readily with that ſpirit of vegetables, that I have elſewhere given a large account of under the title of adiaphorous ſpirit; which argues, that there is ſome affinity between them, or rather, that there is not any manifeſt hoſtility or contrariety.

See the producibility of chymical principles.

The like relation may be found between ſpirit of blood and many other liquors, which it were needleſs and tedious to enumerate.

It may better deſerve the conſideration of a chymiſt, that though there is manifeſtly a near cognation between the ſpirit of human blood and the oil, ſince they both proceed immediately from the ſame body, yet even dephlegmed ſpirit of blood, being ſhaken, and thereby confounded with its oil, will quickly ſeparate again from it; though with ſpirit of wine (which is, according to the chymiſts, a liquid ſulphur, as well as the oil) it will permanently unite, notwithſtanding, that theſe two liquors do (to ſpeak in their language) belong even to differing kingdoms, the one to the animal, and the other to the vegetable.

With the eſſential oils (as chymiſts call them) of aromatic vegetables, or at leaſt with ſome of them, the well rectified ſpirit of human blood ſeems to have a greater affinity. For having taken a dram of this liquor, and an equal weight of oil of anniſeeds, drawn in a limbeck, [*per veſicam*] and ſhaken them well together, they made a ſoft, or ſemi-fluid white coagulum, that continued in that form for a day or two, and probably would have longer done ſo, if I had not had occaſion to proceed further with it.

It may not be impertinent, on this occaſion, to take notice, that becauſe I preſumed, that, though ſpirit of blood would not totally mix with eſſential oils, (as chymiſts call them) it might either communicate ſome ſaline parts to them, or work a change in them; I digeſted a while, in a glaſs with a long neck, ſome rectified ſpirit of human blood, with a convenient quantity of oil of anniſeeds drawn in a limbeck, and found, as I expected, that the oil grew coloured of a high yellow, and afterwards attained to a redneſs; which experiment I the rather mention, becauſe it may poſſibly afford you a hint about the cauſe of ſome changes of colour, that are produced in ſome of the liquors of the body.

Upon the forementioned affinity, or congruity, of the ſpirit of blood, with that of wine, and with (ſome) eſſential oils, I founded a way of taking off the offenſive ſmell of ſpirit of human blood, which is the only thing, that is likely to keep the more delicate ſort of patients from employing ſo uſeful a medicine, as this will hereafter appear to be. But, to deal with a philoſophical candour, I muſt not conceal from you, that, till experience ſhall be duly conſulted, I ſhall retain a doubt, whether the way employed to deprive our ſpirit of its ſtink, will not alſo deprive it of part of its efficacy: but, on the other ſide, I conſider it as a thing probable enough, that theſe aromatiſed ſpirits may, by being impregnated with many of the finer parts of the oils employed to correct their odour, be likewiſe endowed with the virtues of thoſe oils, which are liquors, that chymiſts not improbably believe, to conſiſt of the nobleſt parts of the vegetables, that afford them.

To aromatiſe the ſpirit of human blood, we employed two differing ways, the firſt whereof was this: we took a convenient quantity of well rectified ſpirit of blood, and having put it into a glaſs egg, we added to it as much, or (what may in many caſes more than ſuffice) half as much eſſential oil of anniſeeds, for inſtance; and having ſhaken theſe liquors together to mingle them very well, we placed the glaſs in a fit poſture in a furnace, where it ſhould not have too great a heat: by which means, the ſlight texture of the coagulum being diſſolved, part of the oil (ſometimes a great portion of it) appeared by itſelf floating at the top of the ſpirit; whence being ſeparated by a tunnel or otherwiſe, the remaining liquor was whitiſh and without any ſtink; the ſmell predominant in it being that of the anniſeeds, of which it taſted ſtrongly, though the ſaline ſpirituous parts of the blood did in this liquor retain a not inconſiderable degree of their briſk and penetrant taſte.

The other way I thought of to aromatiſe our ſpirit of blood, was by employing a medium to unite it with eſſential oils: for which purpoſe, in a vinous ſpirit ſo dephlegmed, that in a ſilver ſpoon it would totally burn away, we diſſolved, by ſhaking a convenient proportion, as an eighth part, or a far leſs (according to the ſtrength of the oil) of an eſſential oil (of anniſeeds, for inſtance;) and to this ſolution we added an equal quantity, or ſome other convenient one, of our rectified ſpirit of blood; and having, by ſhaking them, mixed them as well as we could, we ſuffered the expected coagulum (which was ſoft and not uniform) to reſt for ſome time, after which it appeared, that ſome of the oil was revived, and ſwam in drops diſtinct from the other liquor, which conſiſted of a mixture of the two ſpirits, impregnated with the particles of the oil they had intercepted and detained. This liquor abounded with little concretions, made by the concoagulation of the ſanguineous and vinous ſpirits, and theſe, with a very gentle heat, ſublimed in the form of a volatile ſalt, to the upper part of the glaſs; which ſalt ſeemed to have a much leſs penetrating odour, than the meer volatile ſalt of human blood, but had quite loſt its ſtink, and yet retained a conſiderable quickneſs, and ſomewhat of the ſcent of the anniſeeds; the remaining liquor alſo was deprived of its ill ſmell, and moderately imbued with that of the oil.

I thought it worth trying, whether there would be any affinity between our ſpirit (which I perceived contained in it many latent particles of an oleaginous nature) and the highly rectified oil of petroleum, which is a mineral bittumen: and having ſhaken together a convenient quantity of theſe two liquors in a new vial, they preſently turned into a white mixture. And though, after it had for many hours been left to ſettle, the greater part of the oil ſwam above the ſpirit, yet there appeared betwixt the two liquors a good quantity of a whitiſh matter, which ſeemed to be ſomething, that had been produced by the precipitation or union of many particles of the ſpirit and oil, that were more difdiſpoſed than the reſt to combine with one another.

The thirteenth (ſecondary) TITLE.

Of the relation between ſpirit of human blood and the air.

THAT the contact of the air has a ſpeedy and a manifeſt operation upon human blood, is elſewhere ſhewn by ſome experiments of an Italian virtuoſo, ſignior —— and ſome of mine. But whether, after human blood has had its texture ſo much altered, as it uſes to be by diſtillation, it will retain any peculiar relation to the air, I have not been able to make trials enough to determine; but, however, it will not be amiſs to ſet down the chief experiments I made on this occaſion, becauſe they may be conſiderable, as parts of our hiſtory, though they ſhould not be ſo, as arguments deciſive of our controverſy.

THE firſt experiment was quickly made, by thinly ſpreading upon a piece of white paper, (which ought to be cloſe, that it may not ſoak up the liquor) ſome ſmall filings of copper, and wetting them well, without covering them quite over, with a few drops of ſpirit of blood; for, by this means, being very much expoſed to the free fair, the action of the liquor was ſo much promoted, that within a minute or two it did, even in the cold, begin to acquire a bluiſh colour, and in fewer minutes, than one would have expected, that colour was ſo heightened, as to become ceruleous: but, when I put another parcel of the ſame filings into a vial, and covered them with ſpirit of blood, and then ſtopt the vial, to keep it from intercourſe with the external air, the liquor would not in ſome hours acquire ſo deep a colour.

THE other experiment we made, in order to the late propoſed inquiry, was the ſame for ſubſtance, that I had formerly made, (and have elſewhere at large delivered) with the ſpirit of urine, and with that of ſal-armoniac, ſave that, to ſpare our ſpirit of blood, we employed a far leſs quantity of it, than we did of either of the forementioned liquors. For, having, in a clear cylindrical vial of about an inch diameter, put more filings of copper than were requiſite to cover the bottom, we poured upon it but ſo much ſpirit of human blood, as ſerved to ſwim a finger's breadth, or about an inch, above them. This liquor, becauſe of the quantity of air, that was contained in the vial, did within few hours acquire a rich blue colour; and this, after a day or two, began to grow more faint, and continued to do ſo more and more, till it came to be almoſt loſt; but, yet the liquor was not altogether lympid, or colourleſs, as I have often had it with ſpirit of urine, or of ſal-armoniac; which remains of bluiſhneſs I was apt to attribute to the great quantity of air, that was included in the vial with ſo ſmall a quantity of liquor: and though I thought it not impoſſible, but that length of time might deſtroy theſe remains of bluiſhneſs alſo, yet, not having leiſure to wait ſo long, I unſtopped the vial, and perceived, as I expected, that in a very ſhort time, perhaps about two minutes of an hour, the ſurface of the liquor, where it was touched by the newly entered air, became ceruleous, and in a ſhort time after, perhaps leſs than a quarter of an hour, the whole body of the liquor had attained a deeper colour than that of the ſky; which colour, the vial being ſeaſonably and carefully ſtopped, began in two or three days to grow paler again.

THESE experiments would, I queſtion not, to many ſeem manifeſtly to infer a great cognation or affinity (for I know not well what name to give it) between the ſpirit of human blood and the air. But, though I ſhall not deny the concluſion, as it is an aſſertion, I dare not rely on the validity of the inference; becauſe, I have, for curioſity's ſake, made the like experiments ſucceed with other ſpirits abounding with volatile ſalt. I foreſee it may very ſpeciouſly be pretended, that thoſe trials ſucceeded upon the account of ſome ſpirituous parts of the blood, ſince ſpirit of urine is made of a liquor ſeparated from the blood; and that, though the ſal-armoniac that is made in the *Eaſt*, may conſiſt in great part of camel's urine, yet, that, which is made in *Europe*, (where camels are rarities) and is commonly ſold in our ſhops, is made of man's urine, and conſequently its ſpirit may well be preſumed to be impregnated with ſpirit of human blood. And I confeſs, that when this conſideration came firſt into my mind, it appeared ſo probable, that I ſhould perhaps have acquieſced in it, if it were not for what I am going to ſubjoin; namely, that I found by trial, carefully made, that with another volatile ſpirit, made without any ſubſtance, that is afforded by the body of man, I could, with filings of copper, make an experiment very analogous to that above related. But, becauſe, in this trial the reiterated contact of the air produced, in the liquor, not a ceruleous, but a green colour, I am willing to ſuſpend my judgment about the problem lately propoſed, till experience ſhall have further informed me.

I KNOW not, whether it will be worth while to relate, that having, in an unſtopped glaſs, put ſome ſpirit of human blood into a receiver placed upon our pneumatic engine, and withdrawn the incumbent air by pumping; the ſpirit of blood ſeemed to afford leſſer and fewer aereal bubbles, than ſuch a quantity of common water itſelf would probably have done: but, as I lately intimated, I know not, whether this obſervation be conſiderable, becauſe, being not willing to weaken, by expoſing it, a freſh parcel of ſpirit, I know not, whether the paucity of air, obſerved in that lately mentioned, were accidental or not.

The fourteenth (ſecondary) TITLE.

Of the hoſtility of the ſpirit of human blood to acids, whether they be in the form of liquors or fumes.

THAT there is in the ſpirit of human blood ſuch a thing, as a chymiſt or a vulgar philoſopher would call hoſtility, or an antipathy in reference to acids, has been plainly enough, though very briefly, intimated in a paſſage belonging to the third of the precedent titles. But, yet, it may not be impertinent to add in this place, that our ſpirit of human blood exerciſes this hoſtility againſt more than one ſort of acid ſpirits, though perhaps they differ not a little from one another, as ſpirit of ſalt, ſpirit of nitre, ſpirit and oil of vitriol, *aqua fortis*, *aqua regia*, *&c.* and not only againſt factitious acids, but againſt natural ones too, the ſpirit of human blood may diſcover a manifeſt hoſtility, as I found by the conflict it would make with newly expreſſed juice of lemons, which it would put into a confuſed agitation, accompanied with bubbles. And this was yet the more evident, when I employed the volatile ſalt of blood, that is, the ſpirit in a dry form: for having ſqueezed upon a parcel of this ſome juice of lemons, there was preſently excited a great commotion, accompanied not only with froth, but with noiſe. But (to return to the ſtrongly acid liquors made by diſtillation) whether the great commotion, and froth, and hiſſing noiſe, that uſually follows upon the mixture of ſpirit of human blood with any of theſe menſtruums, do proceed from a true hoſtility, or an antipathy deſervedly ſo called, or elſe be a motion to coaleſcence or union; or an effect of the diſturbed motions proper to the differing, but now confounded, liquors; or laſtly, a conſequent of ſome impediment, which the new texture of the mingled liquors gives to the free paſſage of ſome æthereal or other ſubtil permeating matter or fluid, I ſhall not take upon me to determine; but rather, to what I lately told you of the at leaſt ſeeming contrariety of the ſpirit of human blood to acid ſpirits, I ſhall add, (what perhaps you did not expect) that this hoſtility extends even to the inviſible effluvia or emanations of theſe liquors, as may be readily ſeen in the following way, that I long ſince pitched upon to make it not only viſible but manifeſt.

THIS is eaſily done by putting any ſtrong acid ſpirit, as of ſalt, or of nitre, *&c.* into a vial ſomewhat wide-mouthed, and ſome well dephlegmed ſpirit of blood into another; for when I purpoſely inclined theſe glaſſes ſo towards one another, that their lips did almoſt touch, and their reſpective liquors were ready to run out, though neither of the liquors did at all viſibly fume whilſt they were kept aſunder, though the glaſſes were unſtopped, yet, as ſoon as the liquors came to be approached in the way juſt now mentioned, the fumes meeting each other in the air would make coalitions, which would be manifeſtly viſible in the form of aſcending ſmoke, which was wont at firſt to ſurprize the delighted ſpectators; and this production of ſmoke would continue a good while, if the vials were not ſevered to make it ceaſe, which, upon their remove, it would preſently do. I have divers times practiſed a more eaſy way of making theſe fumes conſpicuous; but it belongs more to another paper, and what has been now delivered may ſuffice for my preſent purpoſe.

YET, it may not be improper to take this occaſion to acquaint you with an experiment, that I made to obſerve what the contrary ſalts, that abound in our ſpirit of blood and in ſome acid liquors, would produce, when they were combined and brought into a dry form. I ſhall therefore annex a tranſcript of the experiment I ſpeak of, as I find it regiſtred in one of my note-books.

[WE took ſome pure volatile ſalt of human blood, and having juſt ſatiated it with ſpirit of nitre, we ſlowly evaporated away the ſuperfluous moiſture, that the acid and urinous ſalts might be united into a dry concretion, from which my deſign was to ſeparate them again, the ſalt of blood in its priſtine form, and the ſpirit of nitre in the form of ſaltpetre. To effect this, we put the compounded ſalt into a ſmall bolt head with a long and ſlender neck, and then added to it a convenient quantity of ſalt of tartar, and as much diſtilled water, as would ſuffice to make the mixture ſomewhat liquid, to promote the action of the contrary ſalts upon one another. By which mutual actions we ſuppoſed, that the ſaline ſpirits of nitre, being more congruous to the fixed ſalt than to the volatile, would forſake the ſalt of blood, (which it detained before from flying away,) and give it leave to ſublime; and accordingly, having kept the glaſs, wherein the mixture was made, for a competent time in a convenient heat, we obtained what we looked for, ſince a good proportion of fine volatile ſalt aſcended, in a dry form, into the neck.]

HAVING put to ſome of the ſpirit of human blood a ſmall quantity of exceeding ſtrong ſpirit of nitre, there was, upon the conflict of the two liquors, excited ſo great a quantity of thick white fumes, that I could not but wonder at it, having never ſeen any thing of that kind comparable to it. And theſe fumes circulating long in the cavity of the glaſs, whereof perhaps a tenth part was full of liquor, did many of them, though the veſſel were wide-mouthed, fall back and run down the ſides of the glaſs into the ſtagnant mixture, as if they had compoſed ſtreams of a milky liquor. And when at length, after theſe fumes had diſappeared, we dropt in a little more of the ſame ſmoking ſpirit of nitre, the like ſtrange plenty of white exhalations did preſently enſue, and continue to circulate a great while in the open glaſs, the mixture, in the mean while, appearing reddiſh. Being ſettled, and ſeeming to have been ſo diſcoloured by a fattiſh ſubſtance, we put to it a little rain or diſtilled water, and having by filtration ſeparated it from the fæces, and ſlowly evaporated the thus clarified liquor, the ſaline parts ſhot into cryſtals much of the ſhape, and croſſing one another much after the manner, of ſtriæ of ſalt-petre; but their colour after a while appeared yellow, as if ſome oily ſubſtance were yet mixed with them.

N. B. Though on ſeveral occaſions the ſpirit of blood appeared thus oily, yet, I remember, I had not long ſince ſome diſtilled from another parcel of blood, which, after having been kept a year, was limpid and colourleſs, like an ordinary vegetable ſpirit.

Some of the forementioned cryſtals being put upon well kindled charcoals, did preſently melt and burn away, with a noiſe not unlike ſalt-petre; but the flame ſeemed not quite ſo halituous, and was more differing in colour, being not at all blue but very yellow. After the deflagration was quite paſt, I was curious to ſee, if any fixt ſubſtance was left upon the coals, and found it to be ſomewhat odd; for it was not of a light colour, nor of an incoherent body, like aſhes, but a little lump of a dirty coloured matter, in which I could not perceive an alcaliſate taſte, and indeed ſcarce any at all; and this brittle ſubſtance (for ſuch it was) being held in the flame, became red hot, without appearing deſtroyed by that ignition, no more than afterwards it did by being a good while kept upon a glowing coal.

The fifteenth (ſecondary) Title.

Of the medicinal virtues of ſpirit of human blood outwardly applied.

Having reſided for many years laſt paſt in a place ſo well furniſhed with learned phyſicians as *London* is, I was careful to decline the occaſions of entrenching upon their profeſſion. And though that care did not always ſecure me quiet, yet, I did it ſo far, as that you, to whom my circumſtances are not unknown, will not, I hope, expect, that I ſhould ſay much upon my own experience, of the medicinal virtues of ſpirit of human blood: yet, ſince I had ſome few opportunities to get trials made by practitioners in phyſic, (who were pleaſed very willingly to make them for me,) that I may not leave this ſubject wholly untouched, I will ſubjoin what occurs, either to my memory, or to my thoughts, about it.

When I conſider, that, as far as I have obſerved, we do not meet regularly with any acid ſubſtance, (except perhaps in the *ſuccus pancreaticus*) in a ſound human body; (for the fixt ſalt of blood does itſelf much reſemble ſea-ſalt, whether its ſpirit be acid or no;) whereas the ſeveral parts of it, whether ſolid, as bones, or liquid, as blood, afford in diſtillation ſtore of liquor impregnated with volatile ſalt; I am induced to think it probable, that the ſpirit of human blood, wherein ſuch a ſalt abounds, and whereof it is the main and predominant ingredient, is like to have notable operations upon the human body, and afford medicines of great efficacy in many of its diſeaſes. And though againſt moſt of theſe it is to be internally given, yet there are ſome, againſt which it may be ſucceſsful, when but externally adminiſtred.

For, as well rectified ſpirit of human blood abounds with very ſubtile particles, which in point of taſte, odour, diffuſiveneſs and penetrancy, do much reſemble thoſe of ſtrong ſpirits of urine, of hartſhorn, and of ſal-armoniac; ſo one may very probably expect to find the ſame vertues in the ſpirit of blood, that experience has manifeſted to belong to thoſe other ſpirituous liquors.

I have ſeldom, if ever, ſeen any medicine operate ſo nimbly in fits of the mother, as a well dephlegmed ſpirit of ſal-armoniac; which, as I formerly noted, is in effect mainly a ſpirit of urine, which itſelf is granted to be a liquor ſeparated from blood; for this ſpirit being held to the noſes of hyſterical women, has often in a trice, to the wonder of the by-ſtanders, fetched them out of their fits. Nor is this the conſiderableſt effect, that I have had of this ſpirit, for ſometimes it has, with a ſtrange quickneſs, brought to themſelves patients, that were fallen to the ground, and either really were, or were judged to be, epileptical; and even in agonizing perſons, where it could not recover them, it would frequently for the time bring them out of their ſwoons, and make them know and underſtand the aſſiſtants, and perhaps ſpeak to them too; of which, if it were needful, I could give more than one inſtance. But I ſhall rather add, that if nature be not quite ſpent, and the caſe wholly deſperate, this may be of great advantage, becauſe it allows the phyſician ſome (though perhaps but little) time, and a good opportunity to adminiſter other remedies, which the patient, unleſs excited and brought to himſelf, would not be made to take. Of which I ſhall give you a memorable inſtance in a patient of the very learned Dr. *Willis*'s, who being in the fit of an apoplexy, when he was neceſſitated to go from her out of the town, and leave her in that condition, he committed her to the care of a very ingenious phyſician, who (whether by his direction or no, I remember not) came to me to acquaint me with it, complaining, that they could not hope for any ſucceſs of their remedies, in regard ſhe was ſo ſtupid, and had ſhut her mouth ſo cloſe, that they could not get any down: whereupon I gave him, and told him the uſe of, a very ſubtile ſpirit, that I had by me for ſuch caſes, though I remember not, whether it were of ſal-armoniac, or ſome other volatile or liquid alcali; by applying which to her noſe, the phyſician found he could preſently make her open her eyes, and in part come to herſelf; but then ſhe would again, when the glaſs was removed, ſoon relapſe into her former condition. Wherefore, having by thoſe frequent viciſſitudes gained ſome time, and got a medicine for his purpoſe, he then held the glaſs to her noſe for a good while together; by which means ſhe ſo recovered her ſenſes, that ſhe knew the byſtanders, and being exhorted to take a medicine, that was offered her, which they told her would do her much good, ſhe underſtood them, and ſwallowed it; and though afterwards, upon the removal of the vial, ſhe relapſed into a ſenſeleſs ſtate, yet by the help of the urinous ſpirit they kept her alive, till the very briſk medicine ſhe had taken began to act its part, and make a copious evacuation, which did not only rouſe her, but little by little relieve her: ſo that in a ſhort time ſhe happily eſcaped a danger, that was judged to be very hardly, if at all, ſuperable by any medicines. But here I muſt give you notice, that in ſuch difficult and deſperate caſes I am not content, that a vial, with a ſomewhat long neck, be held to the noſe, but ſometimes order, that little pellets of lint or cotton, or of thin rags, be dipt into the ſpirit and thruſt up into the noſtrils. And the ſame thing I would adviſe, if need ſhould require it, in the adminiſtration of ſpirit of human blood. And as, for external uſes, I make a particular preparation of ſpirit of ſal-armoniac, or of urine, that is more ſtrong and penetrant than that, which is made the more ordinary way: ſo, if I had been furniſhed with ſtore of ſpirit of blood, I would have handled it in a not very unlike manner. And, however, with the little I had, I made the following experiment for trial's ſake. We took ſome dried volatile ſalt of human blood, (being then better able to ſpare that than ſpirit,) and put to it as much ſpirit of nitre, as would juſt ſerve to ſatiate it; and then by evaporation we obtained thence an anomalous kind of compounded ſalt, which afterwards, becauſe we deſired a medicine in a dry form, we ſublimed from a convenient quantity of a well choſen fixed alcali, (if I miſtake not, we took an equal weight of ſalt of tartar,) fit to retain not only the phlegmatic parts, but the oleaginous too, which oftentimes lie concealed in volatile ſalts and liquors, wherein they do not at all at firſt appear, and unto which the greateſt part of their fœtid or offenſive ſmell may probably be imputed: by this means we obtained a dry white ſalt of a very piercing ſmell. But I had no opportunity to try this ſublimed ſalt upon diſeaſed perſons; for whoſe ſake I alſo made uſe of another way to bring over the ſaline part of blood in a liquid form, (which, for the uſe of ſmelling, I for the moſt part prefer to the dry;) for which purpoſe we mixed two parts of dried human blood with three parts of lime, and then diſtilled them with a pretty ſtrong fire; by which means we obtained, as we expected, a pretty deal of ſpirit, unaccompanied with any volatile ſalt in a dry form; which ſpirit ſeemed, even without rectification, to have a ſtronger ſmell, and a more fiery taſte, than other ſpirit of blood after a rectification. And I gueſſed, that if we had taken more or ſtronger lime, we ſhould have had leſs oil and a more piercing ſpirit, ſince the lime would probably have retained moſt of the oil, and perhaps all the ſuperfluous moiſture.

I HAVE likewiſe often found, that ſlighter head-achs have been cured in leſs (and perhaps much leſs) time than a quarter of an hour, by the bare ſmell of ſome of theſe well depurated volatile alcalies; and if I miſremember not, I have been relieved, particularly by that of *H. B.* and I have very rarely for theſe many years uſed, or (thanks be to God) needed any other medicine to free myſelf from pains of the head. And even violent and durable pains of that part have been, if not quite removed, yet much leſſened by the ſame remedy often reiterated, which I have likewiſe obſerved to be uſually enough very effectual in faintings, eſpecially thoſe of hyſterical and hypochondriacal women; which makes it probable, that our ſpirit of human blood, which is a liquor, that in many qualities manifeſtly reſembles other volatile alcalies, (and perhaps ſurpaſſes them,) and which, when well freed from its oil, can by few, if by any, be diſtinguiſhed from other urinous ſpirits, may, by its odour, be available in the forementioned maladies. I expect you ſhould tell me, that the ill ſcent of ſpirit of blood will hinder that ſex from uſing it externally, to divers of whoſe diſtempers it is the moſt proper. To this it may be anſwered, that moſt of thoſe, that find themſelves in pain or danger, would be content to be eaſed or reſcued by an unpleaſant medicine; for we may apply to health, what *Veſpaſian* ſaid of the tax, that was paid him upon the ſcore of urine, *Lucri bonus odor ex re qualibet*. And accordingly we ſee, that ladies themſelves ordinarily make uſe in ſuch caſes of burnt feathers, and in theſe and ſome others of *Caſtoreum*, *Galbanum*, and *Aſa fœtida*, whoſe ſmells are offenſive enough to men. But for the more delicate and nauſeous patients, one may much leſſen the offenſive odour of our ſpirit by long digeſtions, or by reiterated or ſkilful rectifications. And if even then they cannot be reconciled to the odour of ſo good a remedy, that odour may (as was formerly intimated on another occaſion) be corrected by uniting it with a convenient quantity of highly rectified ſpirit of wine; by which means it may perhaps (for I am not ſure of it) loſe ſomewhat of its penetrancy, as well as of its urinous odour, but yet may remain ſubtile and active enough for divers good purpoſes. And if you would not only correct the ſmell of the ſpirit of blood, but make it afford a fragrant one, you may do it by diſſolving in the ſpirit of wine a convenient quantity of ſome aromatic, or other well ſcented chymical oil, whoſe proportion may be found by letting it fall drop after drop into the vial, and frequently ſhaking it to mingle the liquors well, till you find by your ſmell, that the offenſive odour of the ſpirit of blood is ſufficiently obſcured;

ſcured; or (if you will not only correct it, but perfume the liquor) that the mixture is ſufficiently imbued with the grateful odour of the oil, wherewith you compounded it.

I SHALL add on this occaſion, that, if we aim chiefly at correcting or changing the ſmell of ſpirit of blood, we may uſefully employ a chymical oil, more mild or temperate than the aromatic ones of cinnamon or cloves. For trial purpoſely made has informed me, that if the oil of *Rhodium* (which is much eſteemed by perfumers) be ſincerely and ſkilfully made, (which I fear it is not over frequently) a very few drops of it will make an ounce of alcohol of wine ſo fragrant, that this ſolution being ſhaken together with a convenient quantity (perhaps much leſs than an equal one) of well rectified ſpirit of human blood, there will emerge a mixture, that I found to have a ſcent briſk enough, and yet to be not only free from ſtink, but imbued, though not ſtrongly, with the odoriferous particles of the *Rhodium*.

I MUST not here omit, that divers happy practitioners, as well phyſicians as profeſſed chymiſts, do highly extol the oil of amber againſt convulſion fits and other diſtempers of the brain and *genus nervoſum*: and indeed experience has ſo recommended ſome medicines of amber to me, that, in ſome caſes, there are few, that I more willingly give or take. And beſides the great character, that *Helmont* has left of amber diſſolved in ſpirit of wine, experience has brought ſuch credit to it in divers caſes, (for there are ſome caſes and conſtitutions, wherein I ſuſpect it of too much heat) that many patients, as well women as men, had much rather endure the ſmell, than deny themſelves the benefit of the tincture or the oil. And if you have any ſuch patients, perhaps you will not be ill pleaſed to be advertiſed, that you may, according to the formerly mentioned way, employ the high tincture of amber taken with ſpirit of wine, to correct the odour, and increaſe (at leaſt in number) the vertues of ſpirit of human blood. And becauſe it requires ſome ſkill, and not ſeldom a pretty deal of time, to draw this tincture from crude amber, though finely powdered, I bethought myſelf of the following way to draw ſpeedily a ſtrong tincture from the oil itſelf; for, though this oil will not, even by long ſhaking, diſſolve throughly in ſpirit of wine, as the aromatick and other oils lately mentioned will do; yet I found, that, by well ſhaking thoſe two liquors together, and leaving them to ſettle at leiſure, though they would ſeparate into diſtinct maſſes, yet the ſpirit of wine would, even in the cold, extract from the oil a fine tincture of a high yellow colour, little, if at all, different from that of the oil itſelf: of which tincture I afterwards mixed as much with ſpirit of blood, as ſufficed to obſcure the urinous ſmell, and make that of the oil of amber ſomewhat predominant, and as we judged, more ſubtile and briſk than it was before.

THREE things more I have to intimate concerning the external uſe of our ſpirit of blood. The firſt is, that by what has been ſaid of the good effects it may have, when (after it has been, by the lately mentioned or other preparations, imbued with chymical oils) it is ſmelt to, I would by no means be thought to deny, that it is, after theſe changes, fit to be alſo inwardly employed, as I ſhall have, e'er long, occaſion more particularly to declare. My ſecond admonition ſhall be, that, whereas in ſome mixtures it will be hard to hit upon the proportion of the chymical oil, or other things employed to correct the ſmell of the ſpirit of blood, ſo exactly, but that, after the mixture has had ſome time to ſettle, a ſeparation of ſome oleaginous parts will be made; the bulk of the mixture may be freed from it, by pouring all into a glaſs tunnel ſomewhat ſharp at the bottom, after the manner uſed among chymiſts to ſeparate oils from other liquors, and then the mixture, that will run through before the oil, may be kept cloſe ſtopt in a vial by itſelf, and the fragrant oil (unleſs it be of cinnamon or cloves) reſerved for other uſes. And whereas frequently, if not moſt commonly, if the vinous ſpirit were ſufficiently rectified, there will, by the concoagulation of the ſaline and urinous particles, be produced a kind of ſalt; you may either pour the liquid part from it into another vial, and uſe each of them ſeparately without more ado, or elſe, without thus ſeparating them, you may ſublime, with a very gentle warmth, as much as will aſcend from the reſt of the mixture in a very dry form. And this *ſal volatile oleoſum* of ſpirit of blood, when it was duly prepared, I found to be deprived of its former bad ſcent, and perhaps endowed with a fragrant one, and yet to have an odour more ſubtile, briſk, and piercing, than I had thought it reaſonable to expect. The third and laſt thing I would advertiſe, is, that beſides thoſe medicinal uſes, that may be made of the odours of ſpirit of blood ſimple or compounded, it may have conſiderable vertues, applied in ſubſtance as a liquor, by way of fomentation or otherwiſe; which I think the more likely, becauſe the ſpirit of ſal-armoniac has been much commended for mitigating the ſharp pains of the gout, and is ſaid to have been ſucceſsfully uſed in the *Eryſipelas*. And when I conſider, that our liquor is very ſpirituous and penetrating, and ſo fit to ſtrengthen and reſolve, and alſo of an alcaliſate nature, which fits it to mortify acidities; it ſeems very probable, that, by vertue of theſe and other friendly qualities, it may, by being applied in its liquid form, prove good in divers caſes, where the chirurgeon's or phyſician's help is wont to be required.

BUT it is high time for me to proceed from the external to the internal uſes of the ſpirit of human blood.

The ſixteenth (ſecondary) Title.

Of the medicinal vertues of the ſpirit of human blood inwardly uſed.

I Have long been prone to think, that it is not neceſſary the number of ſpecifically different morbific matters (as phyſicians call actually noxious humours or other ſubſtances) in the human body ſhould be near ſo great, as that of the diſeaſes it is obnoxious to; and conſequently, that every diſeaſe, that has a diſtinct name aſſigned to it, does not always require a diſtinct ſort of peccant matter to produce it; but that the ſame hurtful humour, or other agent, may produce ſickneſſes, that paſs for different ones, (and accordingly have diſtinct denominations) only as the ſame morbific agent's bad effects are diverſified, partly by its own greater or leſſer quantity, and more or leſs active qualities, and partly (and indeed chiefly) by the particular natures, or ſtructures and ſituations of the parts, that it invades. To this opinion I have been led by divers inducements, that I ſhall not now ſtay to ſet down; eſpecially, ſince the probability of it may be eaſily deduced, from what frequently enough occurs among ſick perſons, of the metaſtaſes of morbific matters; the ſame acid or ſharp humour, for inſtance, producing ſometimes a cholic, ſometimes after that a palſey, ſometimes a cough, ſometimes a flux of the belly, ſometimes an ophthalmia, ſometimes a violent head-ach, ſometimes convulſions, and ſometimes other diſtempers; as the peccant humour, or other noxious matter, happens primarily to invade, or afterwards to be tranſlated to, this or that particular part of the body. And to the hitherto propoſed notion it is very agreeable, that one remedy, by being capable victoriouſly to oppugn one or two of the principal kinds of morbific matter, may be able to cure differing diſeaſes, eſpecially if it be endowed with any variety of active vertues. And upon this ground I am apt to think, that the ſpirit of human blood, ſkilfully prepared and adminiſtred, may be a good remedy in no ſmall number of internal affections of the human body. And indeed volatile alcalies in general have been in *England* ſo proſperouſly made uſe of in phyſick, ſince the year 1656, (about which time I had the good fortune to contribute ſo to introduce them, as to bring them by degrees into requeſt, by divulging eaſy ways of making them, as well as by declaring their virtues) that I ſee ſmall cauſe to doubt, but that they will hereafter be more generally eſteemed and employed, than yet they are, and will little by little invite phyſicians to prefer them to a great many vulgar remedies, that, for want of better, are yet in common uſe, though they clog or weaken the patient, and want divers advantageous qualities, that may be found in volatile alcalies. For (to apply what has been ſaid to our preſent ſubject, as an inſtance, that may ſerve for other urinous ſpirits) the ſpirit of human blood is endowed with divers qualities, that are both active and medicinal. For it mortifies acid ſalts, which are the cauſes of ſeveral diſeaſes, and, if I miſtake not, of ſome, that are not wont to be imputed to them. It is a great reſolvent, and, on that ſcore, fit to open obſtructions, that produce more than a few diſeaſes. It is both diaphoretick and diuretick, and, on both theſe accounts, fit to aſſiſt nature to diſcharge divers noxious ſalts, and expel divers contagious or malignant corpuſcles, that offend her. It reſiſts putrefaction and coagulation of the blood, gives it a briſkneſs and ſpirituoſity, that promotes the free circulation of the blood, to which it is congeneal; by which means (though not perhaps by theſe only) it becomes a good cordial, and probably againſt ſome poyſons an antidote. And, which is none of the leaſt, nor leaſt extenſive, virtues, it is very friendly to the *genus nervoſum*, and upon that account is like to be very proper in fits of the mother (as they are called,) convulſions, ſome ſorts of head-achs, palſies, incipient apoplexies, ſome ſort of aſthmas, &c. It is alſo balſamical in ſome circumſtances, and may have divers other virtues, that have not yet been obſerved. For a medicine, that does not weaken, nor cauſe great evacuations, nor clog the ſtomach, nor is blemiſhed with the exceſs of any manifeſt quality, but has in itſelf a complex of ſo many uſeful powers, may reaſonably be ſuppoſed, likely to be available in more than a few diſeaſes; ſince a good part of thoſe, that human bodies are liable to, may be powerfuly oppugned by ſome of thoſe excellent qualities, one or more, whoſe confluence may be found in the ſpirit of human blood.

I Presume therefore, that one may rationally propoſe it, as likely to be a good remedy in many diſtempers, eſpecially wherein either ſpirit of urine, or the urinous ſpirit of ſal-armoniac, have been found ſucceſsful medicines; ſuch as hyſterical fits, pleuriſies, coughs, ſome ſcorbutick diſtempers, convulſions, apoplexies, ſome kinds of fevers, head-achs, the jaundice, &c. But I formerly prepared you not to expect, that I ſhould ſay much of the virtues of the ſpirit of human blood (inwardly given,) upon my own perſonal experience. And therefore I ſhall not ſcruple to tell you, that *Helmont* himſelf, as little as he is apt to praiſe other than his own, or the Paracelſian, arcana, more than once commends the ſpirit of cruor, (though that be, in his ſenſe of the word, not yet fully elaborated human blood) againſt the epilepſy, which, he ſays, it will cure even in adult perſons, which is a virtue he expreſly denies to the ſpirit of urine. And a famous writer about the hermetick phyſick (but, if I miſtake not, better verſed in divers other parts of learning, than in chymical arcana,) though he ſo far depretiates ſpagyrical preparations, as to commend the utility but of a very few of them, is pleaſed to put the diſtilled liquor of

Spiritus vitæ, N. 16. Pag. m. 122.

blood into the number of thoſe very few, that he vouchſafes a good character to.

I AM the more inclined to give credit to theſe praiſes of ſpirit of blood, becauſe, as I remember, this was the medicine, that I made uſe of in the following caſe. A young lady, in whoſe family the conſumption was an hereditary diſeaſe, was moleſted with a violent and ſtubborn cough, that was judged conſumptive, and looked upon by thoſe, that gave her phyſick, as not to be cured by any other way, than a ſeaſonable remove from *London* into the French air; but ſhe was already ſo far gone and weakened, and there remained ſo much of the winter, that it was judged ſhe would die before the ſeaſon would make it any way fit for her to undertake ſo long and troubleſome a journey; but if ſhe could be kept alive till the end of the ſpring, there would be ſome hopes ſhe might in *France* recover. On this occaſion being ſollicited by ſome friends of hers and mine, to try what I could do to preſerve her, I ſent her ſome ſpirit of human blood very carefully prepared and rectified, (to which I gave ſome name, that I do not well remember,) upon the uſe of which ſhe manifeſtly mended, notwithſtanding the unfriendlineſs of the ſeaſon; inſomuch, that about the end of *February*, ſhe had gained relief and ſtrength enough to venture to croſs the ſeas, and make a journey to *Montpellier*, whence in autumn ſhe brought home good looks and recovery. If I much miſremember not, the ſame ſpirit of blood, made very pure and ſubtile by the help of a lamp furnace, was the medicine, that I put into the hands of an ingenious and ſucceſsful phyſician, who complained to me, that he had a patient, that had quite puzzled him, as well as baffled the endeavours of other eminent doctors, whom the difficulty of the caſe had invited at ſeveral times to try their ſkill upon him. This man was frequently obnoxious to ſuch violent and tormenting fits of the head-ach, that he could not endure the light, and was offended with almoſt every noiſe or motion, that reached his ears; inſomuch, that he was forced to give over his profeſſion, which was that of a taylor: but upon the conſtant uſe of the before-mentioned ſpirit of blood, (for the other medicines he took were much inferior to it, and had not before been available) he received ſuch relief, as made him with great joy and thankfulneſs return to the exerciſe of his trade; and the phyſician, to whom I gave the remedy for him, told me one circumſtance too conſiderable to be here omitted; namely, that the patient having, by our famous *Harvey*'s advice, been uſed to bleed once in two or three months, the phyſician counſelled him, notwithſtanding his recovery, not abruptly to break off his ancient cuſtom; and the patient thereupon ſent for the ſame chirurgeon, that had been formerly wont to let him blood, and to complain of the great badneſs of his blood; but when this chirurgeon, who knew not what had been done to the patient, came to open a vein again, and perceived what kind of blood it afforded, he was ſo ſurpriſed, that he ſtopped the operation, and aſked the man with wonder, how he came by ſuch florid blood, adding, that it was pity to deprive him of ſo well conditioned a liquor.

THE medicinal vertues, hitherto mentioned, belong to the ſpirit of human blood, as it is pure and ſimple: but it is not improbable, that it may acquire other, and perhaps nobler, faculties, if it be dexterouſly corrected, diverſified, or united with fit ingredients, that is, in a word, ſkilfully altered or compounded.

THESE things may be performed ſeveral ways; for they may be done, either by uniting, as well as one can, by long digeſtion, or frequent cohobations, the ſpirit of human blood with the oils, ſalt, and (if need be) phlegm, of the ſame concrete, into ſuch a kind of mixture, as ſome chymiſts call *Clyſſus*.

OR, ſecondly, by uniting the ſpirit of blood with acids, as with ſpirit of nitre, ſpirit of vinegar, ſpirit of verdegreaſe, oil of vitriol, &c. and employing theſe mixtures, either in their liquid form, or reduced, by evaporation, into chryſtals, or other ſalts; and making uſe of theſe, either as they are, or after a kind of analyſis of them.

OR, thirdly, by uniting our ſpirit with metalline ſolutions, as of gold, ſilver, mercury, and with ſolution of minium, made with ſpirit of vinegar, by mixture of which liquor with ſpirit of blood, and a ſlow evaporation of them, I remember I have had pretty ſtore of finely figured chryſtals.

OR, fourthly, by diſſolving in ſpirit of blood, carefully dephlegmed, ſulphur opened with ſalt of tartar.

OR, elſe, by diſſolving in it ſome metalline bodies, as copper, zink, and iron, which laſt will afford a martial liquor, that, differing much from other preparations of ſteel, that are wont to be made with acids, may probably have ſome virtues, diſtinct from thoſe of the known remedies made of that metal.

BUT I cannot ſtay to enumerate the ſeveral ways, whereby the ſpirit of human blood may be made ſerviceable to the medicinal art. Yet one preparation there is, which though I have already taken notice of in the foregoing title, and therefore can ſcarce mention without ſome repetition, yet I think I ought not to pretermit it on this occaſion; partly becauſe, whereas it was formerly propoſed with reſpect only to the outward uſes of it, I ſhall now conſider it with reference to the inward; and partly becauſe, by this way of proceeding, we may, at once, correct, diverſify, and compound our ſpirit of blood.

THIS operation may be performed two ways, whereof the former is more ſimple than the latter. The firſt is, to add to well rectified ſpirit of blood a double weight, or about an equal one, (as the liquors, eſpecially the volatile alcali, are more or leſs ſtrong) of alcohol of wine: for theſe liquors, being well ſhaken together, will, in very great part, coagulate into ſalt, which, with a very gentle heat, will ſublime in a dry form, in which I found it to have loſt almoſt all its offenſive ſmell. And though, againſt this way of proceeding I know it may be objected, (as was formerly intimated) that the efficacy of the medicine may, as well as the urinous ſmell, be much weakened by this preparation; yet I found this ſalt to retain a conſiderable degree of quickneſs and penetrancy, which its volatility kept me from thinking ſtrange. And experience has perſuaded me, that divers of theſe compounded, or, if I may ſo ſtile them, reſulting ſalts, (which ſome chymiſts call *ſalia enixa*, for all agree not in the ſenſe of that name) though they ſeem to have their activity clogged, may have conſiderable operations both in chymiſtry and phyſic. And why the emergent ſalt we ſpeak of, may not be of that number, I ſee no ſufficient cauſe; [*N. B.*] eſpecially ſince ſuch a kind of mixture, though made with another urinous ſpirit, has had ſuch effects in fevers, as I thought extraordinary. Nor is the liquor, that our compounded ſalt leaves behind, to be thrown away, ſince, if it be dephlegmed, it may afford a not deſpicable liquor, both for medical and mechanical uſes, of which it may here ſuffice to have given you in general this hint.

And if the more ſimple way of altering the ſpirit of human blood, be carried on a little further, by diſſolving in the alcohol of wine, before the conjunction of the two ſpirits be made, a convenient proportion (as perhaps a twentieth, or twenty-fourth part) of an eſſential chymical oil, as of cloves, anniſeeds, marjoram, *&c.* the volatile ſalt, that will be ſublimed from this mixture, will not only be deprived of its ſtink, but endowed with the ſmell and the reliſh of the oil; which, by being thus united with a ſalt very ſubtile and friendly to nature, will leſs over-power and offend the brain and ſtomach, than mere chymical oils are wont to do; and being aſſociated with ſuch agile and penetrating corpuſcles, will with them gain admiſſion into the more inward receſſes of the body, and there exerciſe the virtues, that belong to the vegetables, that afforded the oils, or, at leaſt, to the oils themſelves. In theſe odoriferous aromatic mixtures, the oleaginous particles are, by the intervention of the ſaline ones, brought to mix readily with other liquors, and even with aqueous vehicles, and to continue long enough mixed for the patient to take them commodiouſly. And thus, by this one method, there may be a multitude of *ſalia volatilia oleoſa*, that is, of pleaſing, ſubtile and efficacious remedies for inward uſes, prepared, even as many as the phyſician or chymiſt ſhall pleaſe to make eſſential oils, (or others, that will diſſolve in alcohol of wine;) and if theſe be drawn from cephalick plants, as marjoram, roſemary, lavender, *&c.* or from cephalick ſpices, as nutmegs, cinnamon, *&c.* they will probably afford very briſk and grateful medicines, to relieve and comfort the brain and ſpirits; as they may the heart, liver, and other *viſcera*, if, in the ſublimation, the ſaline particles of blood be aſſociated with thoſe of oils drawn from vegetables, whoſe virtues do peculiarly reſpect thoſe parts.

Other ways might be here propoſed of making remedies, whereof the ſpirit of blood ſhould be the main ingredient. But I willingly leave that work to yourſelf, and thoſe of your profeſſion, if you think fit to proſecute it; ſince my preſent taſk does not require, that I ſhould write like, what I am not, a profeſſed phyſician, but like what I endeavour to be, a diligent natural hiſtorian. And for the ſame reaſon I purpoſely forbear to inſert here ſome chymical proceſſes, that I have met with, of remedies, that admit of diſtilled blood, though I have alſo declined the mention of them, for two other reaſons; one, that the authors do not recommend them upon their own experience; and the other, that theſe medicines being much more compounded, than thoſe I lately propoſed, wherein our ſpirit is mingled but with ſome one chymical oil or other diluted with alcohol of wine, their preparations are leſs fit for my deſign, which leads me to conſider the effects of human blood upon patients, leſs as they are ſanative, than as they are ſigns of qualities, whoſe knowledge tends to the diſcovery of the nature of ſpirit of human blood, and ſo of that blood itſelf.

And this, Sir, it may ſuffice to have, at preſent, ſet down, touching the hiſtory of the ſpirit of human blood; of which, and of the other parts conſtituting that red body, or obtainable from it, I might have given you a far leſs incomplete account, if I had had more leiſure; and if, for want of materials to make experiments upon the entire liquor, and the concreted and ſerous parts of it diſtinctly, and eſpecially to afford a ſufficient quantity of the ſpirit, I had not been ſo ſtraitened, that I was fain to leave many things untried, and to try ſome others in much leſs quantities, and much more unaccurately than otherwiſe ſhould have been done by, Sir,

Yours, &c.

AN APPENDIX TO THE MEMOIRS FOR THE HISTORY of HUMAN BLOOD.

HAVING elſewhere mentioned the reaſons, that moved me to think it fit to ſubjoin an appendix to each of the natural hiſtories, that I drew up, or deſigned, of particular ſubjects; it would be needleſs to trouble you with them in this place, where it may therefore ſuffice to advertiſe you, that the following particulars I have thrown together, as they occured to me, to be annexed to the foregoing hiſtory of human blood, are made up of two ſorts: ſome, which through haſte, or otherwiſe, were prætermitted, when they ſhould have been ranged under one or other of the foregoing titles, and ſo are anſwerable to thoſe, that in the firſt part of theſe memoirs were called *paralipomena*; and others, that are, for the moſt part, of kin to thoſe, that are there ſtiled *addenda*; though ſome of them may be judged to deſerve better the name of ſupernumerary, which yet I thought fit to let paſs among the reſt, becauſe, though they do not directly belong to any of the diſtinct titles of our hiſtory, yet they may obliquely be referred to one or other of them, or are at leaſt capable of being made ſome way ſubſervient to the general deſign of the hiſtory itſelf. But the paucity of the particulars, that I am at preſent furniſhed with, makes me fear it may ſavour of oſtentation, if in ſo much penury of matter, I ſhould curiouſly refer the particulars, that now occur to me, to the differing titles, primary and ſubordinate, that have been enumerated in the ſchemes of our intended hiſtories. And therefore, till I be better ſtocked with materials, I ſhall forbear to make ſcrupulous references of them, or ſo much as conſtantly diſtinguiſh the *paralipomena*, from the other *addenda*; contenting myſelf to refer ſome of them in a general way, and in the order they chance to come to hand, to that part of the memoirs, whether the ſecond, the third, or the fourth, to which they reſpectively ſeem moſt to belong.

IT is hoped, that neither connection nor ſtile will be expected in looſe notes, haſtily ſet down, at ſeveral times, to ſecure the matters of fact, then freſh in memory, from being, as to any neceſſary circumſtances, forgotten.

SOME trials may ſeem to have been made extravagantly, and quite at random, which perhaps would be otherwiſe thought of, but that I judged it not worth while, eſpecially writing in haſte, to ſpend time in ſetting down the inducements I had to make them, or the aims I had in them.

I AM well aware, that ſome few of the following trials may ſeem but repetitions of others, recited in the body of the hiſtory. But theſe were added on purpoſe, that where the event of both trials was the ſame, they might confirm one another, which, where the ſubject has lain uncultivated, is oftentimes a deſirable thing; and where they diſagree in any conſiderable circumſtances, their difference may occaſion further trials, and in the mean time keep us from building dogmatical concluſions upon the circumſtances, wherein they differ.

Particulars referrible to the ſecond part of the HISTORY.

EXPERIMENT I.

THE proportion of the ſubſtances obtainable from dried human blood being, as I formerly noted, very difficult to be determined, becauſe of that difficulty, and the importance of the inquiry, I thought fit to employ ſome blood, that I made a ſhift to collect, ſince the writing of the ſecond part of the foregoing hiſtory, in making another experiment, that we may make the nearer and ſafer eſtimate, of the quantities of the diſtinct ſubſtances ſought after. For this end I cauſed twelve ounces of dried blood to be carefully diſtilled by an expert laborant, well admoniſhed of the difficulty of his taſk, and the exactneſs he was to aim at in performing it. The diſtillation being ended, the ſubſtances obtained were brought me, with this note of their quanties. Twelve ounces of dried human blood yielded, of volatile ſalt and ſpirit together, five ounces, of which we poured off from the wet ſalt ʒxiij+. 54. *gr.* ſo that there remained ℥ij+. ʒij+. 6 *gr.* of volatile ſalt; of fœtid oil there were two ounces; of *caput mortuum* four ounces and two drams: ſo that, in ſpite of all his care, there was loſt, by ſticking to the retorts and other glaſſes, (which, I preſumed, retained little elſe than the more viſcous oil and phlegm) and by avolation of ſome more ſubtile parts, (eſpecially upon pouring the liquors from veſſel to veſſel) about ſix drams. The four ounces and two drams of *caput mortuum*, being diligently calcined, afforded but ſix drams and a half of aſhes: of which very great decrement, the accenſion and conſumption of the more fixed oleaginous part ſeems to be the cauſe. And if it be ſo, we may ſuppoſe, that there is a far greater proportion of oil in human blood, than has been hitherto taken notice of. Theſe aſhes were not white or grey, as thoſe of other bodies uſe to be, but of a reddiſh colour, much like that of bricks; and yet the watchful laborant affirmed he could eaſily know them to be true aſhes, becauſe, that whilſt there remained any thing oily or combuſtible in the *caput mortuum*, it would look like a throughly kindled charcoal (which it would continue to do far longer than one could expect:) but when that combuſtible ſubſtance was quite waſted, the remaining *caput mortuum* would look, in the fire, like dead and ordinary aſhes, though, when they were cold, they appeared and continued red. Theſe aſhes, being carefully elixiviated, afforded five ſcruples of white fixed ſalt, beſides a little, which being caſually got into the contiguous ſand, and thence recovered by water, and reduced to the like white ſalt, amounted to about a ſcruple more: ſo that there remained for the *terra damnata* thirteen ſcruples and about a half, that is, a good deal above twice the weight of the ſalt; whence it appears, that according to this analyſis, the pure fixed ſalt of human blood is but between the 57th and 58th part even of dried blood, and therefore probably, amounts but to the 150th, or perhaps to the 170th part (in weight) of blood, as it flows from the vein opened by a lancet; and the fixed earth, or *terra damnata*, is to the dried blood, that affords it, as 19 and about a half to one.

EXPERIMENT II.

In regard the foregoing experiment, and another of the like nature formerly mentioned, were made with dried and pulverable blood of ſeveral perſons put together, though I knew it would be ſcarce poſſible, in ſo ſmall a quantity of blood, as I could obtain, at once, from one perſon, to find out, with any accurateneſs, the quantities of the ſeveral ſubſtances it was capable of affording; yet, to be able to make ſome tolerable eſtimate grounded upon experience, I was invited to make a trial, whoſe ſucceſs, though in one part of it unlucky, was regiſtered as follows:

An entire parcel of human blood weighing ten ounces and 73 *gr.* being ſlowly diſtilled to dryneſs in a head and body, on a digeſtive furnace, afforded of phlegmatick liquor ℥vij+, ʒij+. 47. *gr.* and of *caput mortuum*, or rather of dry ſubſtance ℥ij+. ʒij. This pulverable matter being beaten and put into a retort, and diſtilled in ſand, by degrees of fire, afforded ʒij+. 48. *gr.* of oil. But there happened an unlucky miſtake about the ſalt and ſpirit; for after the latter was poured off, which weighed but 48 *gr.* the wet ſalt, which ſtuck in good quantity to the lateral and upper parts of the receiver, inſtead of having been waſhed out, as it ſhould have been, with the phlegm of the ſame blood, was waſhed out with diſtilled water; whence we obtained, by ſublimation into the neck of a glaſs egg, ʒj+. 5 *gr.* of dry ſalt: but, by the taſte of the diſtilled water, whence it was ſublimed, it appeared, that all the ſalt had not been raiſed; which invited me to put to it as much good ſpirit of ſalt, as I ſuppoſed to be at leaſt ſufficient to ſatiate it, with deſign to try, whether, by evaporating this mixture to dryneſs, and ſubliming the ſalt, by the help of an alcali, we might not recover all, or almoſt all the volatile ſalt, that had been ſomewhat fixed by the acid ſpirit.

The retort being cut, that the *caput mortuum* might be taken out, it was found to weigh ʒvj+. 12 *gr.* which, being carefully calcined, yielded but two ſcruples and four grains of aſhes, which the laborant ſaid were red. Theſe, being elixiviated, afforded 18 grains of ſalt, beſides the remaining earth or terreſtrial ſubſtance, which I keep by me, becauſe, notwithſtanding all the violence of fire it has undergone, it is of a red colour, which ſeems to ſome to have an eye of purple in it.

EXPERIMENT III.

Spirit of vinegar being put upon the florid ſuperficies of a parcel of human blood, did very quickly deprive it of its freſh ſcarlet colour, and make it of a dark or dirty colour.

EXPERIMENT IV.

The juice of a lemmon ſqueezed upon the florid ſurface of blood, did preſently ſomewhat impair the colour, but did not appear to alter it any thing near ſo much, as the ſpirit of vinegar had done.

EXPERIMENT V.

JUICE of orange changed the colour of the florid ſurface of blood, leſs than juice of lemmons had done.

EXPERIMENT VI.

THE black, or lower part of a portion of human blood being turned uppermoſt, and thereby expoſed to the air, within half or three quarters of an hour, (ſomewhat more or leſs) acquired, by the contact of it, a pleaſant and florid colour.

EXPERIMENT VII.

BUT if upon the black ſurface of the blood ſome good urinous ſpirit (as that of ſal-armoniac) were dropped, there would be an alteration produced in a trice; and a pleaſant red colour, though perhaps ſomewhat inferior to that produced by the contact of the air, would preſently appear on the ſurface of the blood.

EXPERIMENT VIII.

FIXED alcalies, or lixiviate ſalts reſolved *per deliquium*, did likewiſe alter the black ſuperficies of the blood to a red colour, but not ſo florid or pleaſant, as that produced by the urinous ſpirit above-mentioned.

EXPERIMENT IX.

THE freſhly drawn juice of the leaves of ſcurvy-graſs being dropped upon the black ſuperficies of a lump of human blood, ſeemed preſently to make ſome change in the colour of it, making us judge it ſomewhat reddiſh and inclinable to floridneſs.

THE ſeven foregoing notes ſuppoſe it to be already known, that when healthy blood is ſuffered to ſettle in a porringer, that ſurface of the concreted part, which is expoſed to the air, will be adorned with a fine red colour; and if the ſame maſs be turned upſide down, that, which before was the lower ſurface of it, will appear of a very dark and blackiſh colour.

EXPERIMENT X.

HAVING, for trial's ſake, almoſt filled a vial, capable of containing by gueſs near a pound of human blood, with a mixture of that liquor, and ſome rectified ſpirit of wine, whoſe proportion I cannot remember, but gueſs it was a fourth or eighth part; at the end of above three years, looking upon the ſame glaſs, ſtopped with nothing but a cork, we found it coagulated, or to ſpeak more warily, in a conſiſtent form. And the veſſel being unſtopped, there appeared no ſign of putrefaction in the blood; and having ſmelt to it, we could not perceive, that it did at all ſtink: ſo balſamick a virtue has dephlegmed ſpirit of wine to preſerve human blood.

EXPERIMENT XI.

WE took a piece of fibrous or concreted blood, of the bigneſs of a large bean (or thereabouts) and having put it into a ſmall glaſs veſſel with a flattiſh bottom, we poured on it as much highly rectified vinous ſpirit, as might ſerve to cover it, though it had been twice thicker than it was; then we lightly covered this open-mouthed glaſs with another, and ſet the veſſel in a quiet place, that the vinous ſpirit might have leiſure to imbibe the ſerous or aqueous parts of the blood, and thereby harden that yet ſoft ſubſtance; and, in effect, it quickly ſeemed to have gained a ſuperficial cruſt, but the internal parts continuing yet ſoft, we left the liquor upon the blood for a day or two longer, and then we found, that the action of the liquor had quite penetrated the lump of blood, and made it moderately hard and friable.

THIS experiment having been made in the cold, may much confirm a trial elſewhere mentioned to have been made to the ſame purpoſe; and both of them together induced me to fear, that two or three ingenious writers, that, in their chymical receipts preſcribe ſolutions and tinctures of concreted blood in ſpirit of wine, have ſet down the pompous proceſſes, wherein theſe operations are preſcribed, rather according to conjectures than experience.

EXPERIMENT XII.

IT may be of ſome uſe to the ſpeculative to know, how much volatile ſalt of blood is diſſoluble in water or phlegm; and therefore, having cauſed an ounce of diſtilled water (for common water, becauſe of ſome ſaltiſhneſs, that uſually accompanies it, would not have been ſo proper on this occaſion) to be carefully weighed out, we put into it, little by little, ſome dry and white volatile ſalt of blood, and ſhook it well into the liquor, to make it diſperſe the better: we allowed it alſo a competent time for ſolution; and by this means, we found, that ℥i. of water would diſſolve at leaſt ʒij. that is, a fourth part of its weight of dry ſalt, and that in the cold; for, afterwards, by the help of heat, we made the ſame liquor diſſolve near five and 20 grains more. In which laſt part of the experiment I had a further aim, which was to try, whether, upon the refrigeration of the liquor, the diſſolved ſalt would not ſhoot into cryſtals of obſervable figures; but the event anſwered not at that time my deſire, yet left me not without ſome intention to reiterate the experiment, if I ſhall get another opportunity.

POSTSCRIPT.

EXPERIMENT XIII.

WE put the abovementioned ſolution into a retort, to be drawn off with a pretty quick heat, (which on this occaſion we preferred to a much ſlower one) and thereby obtained a diſtilled liquor, that contained all the volatile ſalt, ſave a little, that eſcaped in a dry form; which liquor taſted ſtrong enough to paſs for quite, or at leaſt almoſt, as briſk a liquor, as moderate ſpirit of blood drawn the common way, and conſequently diſcovered near enough, what proportion ſhould be taken of the aqueous ingredient to the ſaline, when one would make ſuch a ſpirit. The knowledge of which proportion may probably eaſe us of ſome trials, that would otherwiſe be neceſſary to find it out, when we are (as we may often be) leſs ſtored with ſpirit than with volatile ſalt, and deſire to employ this in a liquid form; in which, we are wont to call it, for diſtinction's ſake, the aqueous (not the phlegmatic) ſpirit of blood.

IF opportunity had not been wanting, we would have tried, whether, by repeating the diſtillation twice or thrice, a better or ſtricter union of the ſalt and liquor would not have been effected: and this, the rather, becauſe, having ordered the vial, that contained this aqueous ſpirit, in which the water had been, if I may ſo ſpeak, ſuperonerated, to be kept ſtopt during a froſty night, we perceived at the bottom of the glaſs (what we had miſſed of before) a pretty deal of volatile ſalt coagulated or ſhot into cryſtals, though the cryſtals, that were this way obtained, were fine and clear, and ſome of them larger than ſpangles, yet being much more numerous than we deſired, by adhering cloſely and confuſedly enough to one another, they kept us from being able to diſcover the figure of particular grains, and made me ſomewhat doubt, whether the ſingle cryſtals were all of them of the ſame ſhape; all that I could clearly diſcern being, that divers of thoſe concretions were flat thin plates, with fine rectilinear angles, that inclined us to think, that if the whole plains could have been perfectly diſcovered, their broadeſt ſurface would have been found hexagonal, or of ſome polygon figures very near of kin to that.

EXPERIMENT XIV.

WE put an ounce of diſtilled water, wherein we diſſolved as much volatile ſalt of human blood, as it would well take up, into a glaſs egg, and expoſed it during a froſty night to congeal; which we did with deſign to diſcover, whether, as the ſaltneſs, that is in ſea water keeps it here in *England* from freezing, (at leaſt in ordinary winters,) ſo the volatile ſalt of human blood, which much reſembles the other in taſte, would have the like effect upon water, eſpecially if it were fully impregnated therewith. To this conjecture the event was anſwerable, the froſt having produced no ice in our ſolution, nor having ſo much as made any of the ſalt manifeſtly ſhoot, (as I wiſhed it had done, hoping thereby to diſcover ſomewhat about the figuration of the ſalt of human blood.)

AND, though afterwards we removed it into a frigorific mixture, that would probably have frozen beer and ale, and perhaps the weaker ſort of French wine; yet, we did not perceive it to glaciate any part of our ſolution, but only made it let fall a pretty deal of matter, that ſeemed to be feculent, (for what it was, I had not opportunity to examine.)

EXPERIMENT XV.

SEA-SALT diſſolved in water renders that liquor much more difficult to be frozen, than it was before; and yet being joined with ice or ſnow, the other ingredient of our frigorific mixture, it does, when outwardly applied, very much conduce to the artificial congelation of it, which uſually would not ſucceed without it. Wherefore, to try whether, as volatile ſalt of human blood being diſſolved in water, did, as was formerly noted, hinder it from freezing, ſo it would, outwardly applied, highly promote its glaciation; we mixed by gueſs about a ſcruple of this ſalt with a convenient quantity of beaten ice, and having put into this mixture a ſomewhat ſlender pipe of glaſs with common water in it, we found, after a while, the water, that lay in the lower part of the glaſs veſſel, and was ſurrounded by the mixture, was turned into ice.

EXPERIMENT XVI.

TO try ſome ſuſpicions I had about the ſaline and aqueous parts, that I thought might lie concealed in the fibrous or conſiſtent part of human blood, I cauſed ſome of it to be in an open and ſhallow glaſs expoſed to the air in a froſty night, and the next morning found it to be lightly frozen, and the ſurface of the ice prettily figured with reſemblances of combs, with teeth on both ſides or edges; on which account theſe figures did not ill reſemble thoſe, that I have oftentimes obtained, by ſlowly coagulating into ſalt a ſolution of ſal-armoniac made in common water.

IN the ſecond part of the foregoing memoirs I have not ſaid any thing of the medicinal virtues of human blood itſelf, (for thoſe of the ſpirit belong to the fourth part) and though I might now, if I thought fit, ſay ſomething not impertinent to that ſubject in this appendix, both out of ſome printed books and my own obſervations; yet, I now forbear to do it, not only for a reaſon, that it is not neceſſary I ſhould here declare, but becauſe four or five proceſſes, that I have met with about human blood in *Paracelſus*,

Paracelſus, *Burgravius*, (famous for his biolychnium made of that ſubject) and one or two more, about the tranſplantation of diſeaſes by means of the patient's blood, are ſuch, as either I do not well underſtand, becauſe of their being (probably on purpoſe) obſcurely pen'd, or ſeem in themſelves unlikely; of which ſort is the biolychnium, or lamp of life, in which it is pretended, that the blood is ſo prepared, that the ſtate of the health of the perſon, whoſe it is, may be diſcovered by the manner of the burning of the flame it affords, (though he be perhaps at a great diſtance from it,) and his death by its extinction. Beſides that, as I have elſewhere noted, ſome circumſtances relating to the aſhes of human blood, make me doubt, whether ſome of theſe proceſſes were not rather the products of fancy than experience. And, though I think thoſe medicines leſs improbable, that, without much deſtroying the texture of the blood by fire, aim at tranſplanting diſeaſes by its intervention, yet I thought fit to decline tranſcribing the forementioned medicines, till experience ſhall warrant me to do it. And I ſhall alſo at preſent forbear to ſet down my own trials, becauſe I have not yet ſeen the event of them: but, yet, I ſhall invite you to endeavour with me to prepare two, that, if they ſucceed, may afford, eſpecially the laſt of them, conſiderable medicines. The firſt medicine, that I attempted, was, by putting to ſalt of tartar oil of human blood, inſtead of oil of turpentine; and by keeping them long, and ſtirring them frequently, in the open air, to make ſuch a ſaponary concretion, as is not unknown to many in *London* by the name of *Matthews*'s corrector, which, as he made it with common oil of turpentine, though it ſeem but a ſlight compoſition, is yet eſteemed and employed with good ſucceſs by ſome doctors of phyſic and other practitioners in *London*. To make the other medicine, we endeavoured to unite, by long digeſtion, the ſalt, ſpirit, and oil of human blood, into a mixture, which ſome chymiſts (for their terms are not by all of them uſed in the ſame ſenſe) call a clyſſus: but, having begun this, without having had time to finiſh it, we ſhall ſay no more of it, but that divers chymiſts may not improbably look upon this ſort of compoſitions, as one of the nobleſt ſort of preparations, that many a drug is capable of.

Particulars referrible to the third part of the HISTORY.

EXPERIMENT I.

A YOUNG man having bled into a porringer, and the blood having been kept ſeveral hours, that a ſufficient ſeparation might be made of the coagulated or conſiſtent part and the fluid, the fibrous portion and the ſerum were ſeparately weighed; and the difference of the two maſſes, in point of weight, was not ſo great as one would have expected, the curdled part of the blood weighing about ſix ounces, and the ſerous part not many drams from that weight. This trial is here ſet down, that, by comparing it with ſome others, one may ſee what difference there is between the bloods of ſound perſons, as to the proportion of the ſerum, and the concreted part.

EXPERIMENT II.

HUMAN urine having firſt (that I know of) by the very ingenious Mr. *Hook*, and oftentimes by me, been obſerved, when frozen, to have on the ſurface of the ice figures not ill reſembling combs or feathers; the great affinity generally ſuppoſed to be betwixt urine and the ſerum of blood made me think fit to try at once, whether this laſt named liquor would freeze with ſuch a degree of cold, as would eaſily, and yet not very eaſily glaciate water, and whether, in caſe it ſhould freeze, the ice would have a ſurface figured like that of frozen urine. But, having for this purpoſe expoſed ſome ſerum of human blood to the cold air, in two freezing nights conſecutively, the ſerum was not found to congeal, though ſome grumous parts of the ſame blood did, as has formerly been noted; yet I ſcarce doubted, but an exceeding hard froſt would have produced at leaſt a thin plate of ice upon the ſurface of our liquor. And to confirm this conjecture, we took the ſame ſerum, and having ſtrained it through a linen cloth, to ſeparate the liquor, as much as by that way we could, from any clotted or fibrous parts, that might have lain concealed in it, we put it into a ſhallow concave glaſs, and laid that upon ſome of our frigorific mixture made of ice and ſalt, which we have deſcribed and often made uſe of in the hiſtory of cold. By this means the expoſed ſerum, being frozen from the bottom upwards, there appeared here and there upon the ice contiguous to the air certain figures, that did not ill reſemble thoſe of conglaciated urine.

EXPERIMENT III.

HAVING formerly had occaſion to obſerve, that man's urine would tolerably well ſerve for what they call an inviſible ink; and having conſidered (when I remembred this) the great affinity, that is ſuppoſed to be between urine and the ſerum of blood, I thought fit to try, whether the latter might not be employed like the former to make a kind of inviſible ink. To this effect we took ſome ſerum of human blood, and having dipt a new pen in it, we traced ſome characters upon a piece of white paper, and having ſuffered them to dry on, we held the unwritten ſide of the paper over the flame of a candle, keeping it always ſtirring, that it might not take fire: by which means, the letters, that had been written, appeared on the upper ſurface of the paper, being, though not of an inky blackneſs, yet of a colour dark enough to be eaſily legible, and very like to ſome others, that, having been purpoſely written with freſh urine, and made viſible, by heat, were compared with them.

Particulars referrible to the fourth part of the HISTORY.

EXPERIMENT I.

I CONFESS the defectiveneſs of our hiſtorical knowledge of human blood extravaſated has been ſuch, that among the authors I have had occaſion to peruſe, I have met with ſo few matters of fact delivered upon their own knowledge, that the things I have thought fit to tranſcribe out of their books into this little tract, do ſcarce all of them together amount to half a ſheet of paper: but yet I would not impute this penury, either to the lazineſs or the ignorance of writers, but rather to this, that they wanted ſome perſon, exerciſed in deſigning natural hiſtories to excite their curioſity, and direct their attention; there being many, that would enquire, if they knew what queſtions were fit to be aſked about a propoſed ſubject, as for inſtance human blood, and what reſearches ought to be made to diſcover its nature. Upon this account I hope, that after ſome time the foregoing ſcheme of titles, and the papers, that refer to it, will give occaſion to a great many more experiments and obſervations about the blood, (and perhaps other liquors of the human body) than hitherto have been publiſhed by others, or are now imparted by me. Which laſt words I ſet down, becauſe I would not be thought guilty of the vanity of pretending to have near exhauſted the ſubject I have treated of; ſince, beſides other deficiencies, I now perceive, that I wholly omitted a conſiderable title, which might either have been referred to the primary ones of the firſt order, or employed as a kind of preliminary to the ſecondary titles of the hiſtory of the ſpirit of blood. This pretermitted title ſhould have been, *of the ſeveral ways of diſtilling human blood*; ſince, according to theſe, the produced ſpirit, ſalt, &c. may be conſiderably diverſified.

UPON this account I thought fit to diſtill three portions of dried blood, each with a differing additament. The firſt with a mineral alcali, quicklime: the next with a vegetable alcali, calcined tartar: and the third with a ſulphureous acid, oil of vitriol. And, though ſome accidents kept me from proſecuting the trials as I deſired, yet the firſt having ſucceeded indifferent well, and the others not having wholly miſcarried, I ſhall ſubjoin the accounts of all three, as they were ſet down in my notes.

HAVING obſerved (*Exper.* I.) that divers bodies, when they were diſtilled with quicklime, afforded liquors differing from thoſe they would have yielded, if they had been diſtilled, either *per ſe*, or with ſome vulgar additaments; we took ℥v. of concreted, but not dried human blood, and having mixed it with an equal weight of quick-lime, (ſuch as I could procure, but not ſo ſtrong as I have often ſeen,) we diſtilled it by degrees of fire in a retort placed in ſand, by which means we obtained a large proportion of reddiſh ſpirituous liquor, which did not ſeem conſiderably phlegmatic, together, with ſome oyl, which was but in very ſmall quantity, the reſt being probably kept back, (and perhaps ſome of it deſtroyed) by the lime: and of this little oil, that did come over, there was a ſmall portion, that ſunk in the ſpirit, the reſt ſwimming upon it.

THE abovementioned ſpirit being put into a ſmall head and body, was ſet into a digeſtive furnace, to rectify at leiſure with a very gentle heat, and the receiver was three or four times ſhifted, that we might obſerve, what difference, if any, there would be betwixt the ſucceſſively aſcending portions of liquor. The firſt ſpirit, that came over, did not ſmell near ſo rank, as that is wont to do, that is diſtilled *per ſe*. This obſervation belongs alſo to the three or four ſucceeding portions of liquor; probably, becauſe the lime had better freed the ſpirit of the firſt diſtillation from the fætid oil, many of whoſe particles are wont, though unperceivedly, to mingle with it, when it is drawn over without additament. The rectified ſpirit, which was clear and colourleſs, had a taſte much ſtronger than its ſmell; for a ſmall drop of it upon the tongue had ſomething of fieryneſs, that was ſurprizing, and laſted longer than one would wiſh; which made me doubt, whether the ſpirituous part of the blood had not carried up with it ſome of the fiery parts of the quick-lime; which doubt, if future trials reſolve in the affirmative, one may expect ſome uncommon effects from ſuch a ſpirit, which, in this caſe, would be enriched with a kind of volatiliſed alcali, a thing much deſired by many chymiſts and phyſicians. Upon occaſion of this ſuſpicion, we dropt a little of it into a ſtrong ſolution of ſublimate in fair water, and it ſeemed at the firſt contact to make a precipitate a little inclining to yellow, (as I have obſerved the ſaline parts of quick-lime to do in a greater meaſure,) though afterwards the precipitate appeared white, like that made with ordinary volatile liquors of an urinous nature.

BUT, becauſe I expected, that our alcaliſate ſpirit of blood, if I may ſo call it, would have ſome peculiar qualities, diſcriminating it from the ſpirit drawn without addition; I thought fit to make a few trials with it, whoſe event juſtified my conjectures. For having put into a glaſs egg with a ſlender neck ſome of our well rectified ſpirit, it did not then afford any volatile ſalt in a dry form, (though afterwards, if I miſtook not, by another trial, we at length obtained a little;) and having continued the trial ſomewhat obſtinately, we found the ſpirit to have, by the action of the fire, loſt its limpidneſs, and to have been made muddy or troubled.

Having mingled another portion of it with a highly rectified ardent ſpirit, and kept them all night in the cold, no coagulation enſued, nor could we perceive any after it had been kept divers hours in a moderate heat: but the mixture acquired a yellow colour, and let fall, ſomewhat to our ſurprize, a pretty deal of darkiſh powder, though not enough to invite us to make any trials upon it.

We put to another parcel of our ſpirit ſome good ſpirit of ſalt; but, though they ſmoked much at their meeting, yet we obſerved no noiſe nor bubbles upon their commixture.

And having mingled another portion with oil of vitriol, though there was produced a very great ſmoke, and beſides that an intenſe degree of heat, (the quantity of the matter conſidered,) yet there was no viſible ebullition, nor any noiſe or bubbles produced, but the colour of the oil of vitriol was very much heightned, the mixture growing almoſt red.

From theſe, and the like phænomena, one may gather, that our alcaliſate ſpirit of blood is in ſeveral things differing from the ſimple. Whether this diſparity will make it a more potent medicine, or make it, by too much participation of the fiery parts of the lime, a leſs ſafe remedy, future experience muſt diſcover. But it ſeems not improbable, that either as a medicine, or as a menſtruum, if not in both capacities, it may be a not inconſiderable liquor; for which reaſon I have made my account of it the more circumſtantial.

Experiment II.

We took ℥ij of tartar calcined to whiteneſs by equal weight of (kindled) nitre, and mingled this alcali with ℥ij of dried and powdered human blood. This mixture being diſtilled in a retort in a ſand furnace, made it appear, by its productions, that quicklime, on theſe occaſions, acts otherwiſe upon the blood, than other alcalies do. For, whereas the diſtillation, wherein lime was employed, afforded us, as has been noted, a ſpirit, that, before rectification, was very ſtrong, and unaccompanied with dry ſalt; the calcinatum of nitre and tartar afforded us, at the very firſt diſtillation, a ſpirit leſs ſtrong; but withal, ſo much volatile ſalt as covered almoſt all the inſide of the receiver, not now to mention the difference of their reſpective *caput mortuums*. And, though the ſtrong ſaline ſpirit of blood made with quicklime did not, as we lately noted, make an efferveſcence with acid ſpirits, yet this volatile ſalt readily did it upon the affuſion of ſpirit of ſalt.

Experiment III.

Besides the fixt alcaliſate additaments, with which I diſtilled the dried blood of men, I thought fit to add to it a very acid additament, *viz.* oil of vitriol; and this, the rather, becauſe I had long ſince found by trial, (and, if I miſremember not, have elſewhere related) that this liquor being mixed with ſome other bodies, particularly with ſome belonging to the animal kingdom, did in an odd manner mingle its own ſubſtances (for I take it not to be a ſimple body) with them, and notably diverſify the products of the diſtillation. We put therefore upon ℥iij. of powdered human blood an equal weight of oil of vitriol, and left them for ſome time together, to try, if, by the action of this corroſive menſtruum, though upon a body not of a mineral nature, ſome heat would not be excited; and accordingly we found, that after a while, though not at the very firſt, the mixture grew ſenſibly warm. Then we removed the retort into a ſand furnace, and diſtilling it by degrees of fire, we had a ſpirit, which was preceded by a pretty deal of phlegmatic liquor of an odd ſulphureous ſmell, but ſo ſtrong and laſting, that I could not but wonder at it. The *caput mortuum* I was fain to let alone, becauſe I had ſome inducements to ſuppoſe, that it was of ſo compounded a nature, that I ſhould not, in my preſent circumſtances, have the opportunity to examine it thoroughly. But, it ſeemed remarkable, that, notwithſtanding the great acidity of oil of vitriol, and the fixative power it exerciſes on many bodies wherewith it is committed to diſtillation, our experiment afforded us a pretty quantity of volatile matter in the form of a white ſalt. But, indeed the ſmell and taſte of it were ſo uncommon, that I was troubled I had not then conveniency to examine it carefully, much leſs, to try, whether it had any peculiar virtues or operations in phyſic; though I had then by me a glaſs inſtrument, that I purpoſely provided to obviate the great inconvenience, that is uſually met with, and has been often complained of by me as well as others, in the way chymiſts are wont to imploy, when they are put to make repeated ſublimations of volatile ſalts, whether alone or with additaments. Of this inſtrument I cannot now ſtay to give you an account; but if it continue to appear as uſeful as expeditious, I may hereafter do it by preſenting you one ready made.

Having ſet down theſe preliminaries, I ſhall proceed to

Experiment I.

To ſome naturaliſts and phyſicians, that delight to frame hypotheſes, perhaps it may not be unwelcome to know, that, for curioſity's ſake, we attempted to make *aurum fulminans*, by precipitating a ſolution of gold (made in *aqua regia*) with ſpirit of human blood, by dulcifying the precipitate with common water, and then drying it leiſurely; and that, by this means, we ſucceeded in the attempt.

Experiment II.

Having into a wide-mouthed glaſs put as much ſpirit of blood, as would more than cover the ball of a ſmall ſealed weather-glaſs, and ſuffered this inſtrument to ſtay a while, that the ambient liquor and the included might be reduced to the ſame temper, as to heat and cold; we poured on ſome ſpirit of verdigreeſe made *per ſe*, and obſerved, that, though this ſpirit, with ſome other volatile ſaline liquors, had a very differing operation, yet working on our ſpirit of blood, with which it made a conflict, and excited bubbles, there was produced in the mixture a degree of warmth, that was not inſenſible on the outſide of the glaſs, but was much more ſenſible in the thermoſcope, whoſe liquor, being hereby rarified, aſcended to a conſiderable height above the former ſtation, towards which, when the conflict of the two liquors was over, it began, though but ſlowly, to return.

Experiment III.

Having by degrees mixed our ſpirit of blood with as much good ſpirit of nitre, as it would manifeſtly work on, there was, not without noiſe, produced great ſtore of bubbles by their mutual conflict; which being kept in a quiet place, till after the liquors had quite ceaſed to work on one another, it began to appear, that, notwithſtanding all our care to free the ſpirit of blood from oil, ſomething of oleaginous, that had been concealed in it, had been manifeſted, and partly ſeparated by this operation; ſince not only a ſomewhat red colour was produced by it, but, after a while, the ſurface of the liquor was covered with a film, ſuch as I have often obſerved in ſaline liquors copiouſly impregnated with antimony or other ſulphureous bodies. And this thin membrane had its ſuperficies ſo diſpoſed, that looking upon it with eyes placed conveniently in reference to it and the light, it did to me, and other perſons, that did not at all look on it from the ſame place, appear adorned with vivid colours of the rainbow, as red, yellow, blue, and green; and, as I remember, in the ſame order, that theſe colours are to be ſeen in the clouds.

Experiment IV.

Having unexpectedly found, amongſt ſome other long neglected glaſſes, a vial, that was written upon above twelve years before, and inſcribed ſpirit of human blood, it appeared to have been, by I know not what accident, very looſely ſtopt, and yet not ſo, as to give me cauſe to think, that the liquor was much waſted: but notwithſtanding this, and that the liquor had acquired a deep colour, almoſt like that of red wine; yet it was ſo diſpirited and ſtrengthleſs, that it appeared to be very little other than nauſeous phlegm. Which obſervation I therefore think not unworthy to be preſerved, becauſe by it we may gueſs, how little a portion of the noble and genuine ſpirit or ſalt may ſuffice to make a liquor paſs for ſpirit of human blood.

Experiment V.

In a froſty ſeaſon we expoſed, late at night, two or three ſpoonfuls by gueſs of ſpirit of human blood, that was not of the beſt, being, at the utmoſt, but moderately ſtrong. And though the cold of that ſeaſon had throughly frozen a vial almoſt full of oil of vitriol, and the night, wherein our ſpirit was expoſed, was (at leaſt) moderately froſty; yet, the next morning, we did not find ſo much as any ſuperficial ice upon it: but having removed the vial into a mixture of powdered ice and common ſalt, we found, in no very long time, that moſt part of the ſpirit was turned into thin plates of ice, which joined cloſe together, and had their edges upwards, like thoſe of the leaves of a book, when it is held with its back downwards.

Experiment VI.

To make a further trial of that imperfect one mentioned in the eighth ſubordinate title, we took a clot of human blood of the bigneſs of a bean, or thereabouts, and having put it into a vial in ſuch manner, that that part, which before was contiguous to the air, and for that reaſon was florid, was now the undermoſt, and the other, which was blackiſh, lay now uppermoſt, we made haſte to pour upon it as much ſpirit of human blood, as was more than ſufficient to cover it, and perceived, that the contact of it preſently began to leſſen the blackneſs of the ſurface of the blood, and bring it to a conſiderable degree of floridneſs: and to try whether that would continue, we ſtopt the vial, and ſet it by till the next morning, (for it was then night,) when looking upon it, we found the ſuperficial colour not to be black, but ſtill red.

Experiment VII.

Upon the powder of dried human blood we put (in a ſmall vial) ſome of the rectified ſpirit of human blood, which quickly diſſolved part of it, and acquired a deep and pleaſant colour. But highly rectified ſpirit of wine being put upon ſome of the ſame powder in a like glaſs, did not in many hours acquire any manifeſt tincture, and got but a pale yellow one, even after having been for a longer time kept in a moderate heat. And yet common water, being put upon another portion of the ſame powder, did quickly enough appear, by the colour it acquired, to have diſſolved a pretty deal of it.

EXPERIMENT VIII.

SOME of our ſpirit of human blood being put upon ſome curious vitriol, that I had as a rarity (if I miſtake not) from the *Eaſt Indies*, part whereof was in lumps, and part beaten to powder; that liquor, which was put upon the former, being able to diſſolve it but ſlowly, made little or no froth; but the ſpirit, that was put upon the latter, by haſtily working on it, produced a manifeſt one. And the ſolutions made of both parcels of vitriol were of a deeper and more lovely blue, than the mineral itſelf had been: nor did I obſerve in them any precipitate of a dark colour, as I have done upon the mixture of ſpirit of urine and ordinary vitriol.

EXPERIMENT IX.

HAVING with a clean pen drawn ſome letters upon white paper with ſpirit of human blood, and, as ſoon as it was dry, moved the unwritten ſide over the flame of a candle, we found, that this liquor may, for a need, be employed as an inviſible ink, that ſeemed to be ſomewhat better, than thoſe formerly mentioned to have been afforded us by ſerum and urine.

EXPERIMENT X.

HAVING found by trial, that divers ſalts, ſome that are volatile, and ſome that are not, being put in powder into water, will, whilſt they are diſſolving, ſenſibly refrigerate it; and on the other ſide, that ſome very ſubtile ſpirits actually cold, being put into cold water, will quickly produce in it a ſenſible warmth, I thought it would not be amiſs to try, what ſpirit of human blood would do, when employed after the ſame manner. Having therefore placed a ſealed thermoſcope in an open mouthed glaſs, furniſhed with as much diſtilled water as would cover the ball of the inſtrument, we left it there for a while, to bring the internal liquor and the external to the ſame degree of coldneſs. Then we poured upon the immerſed ball two or three ſpoonfuls of ſpirit of human blood (which was all we could ſpare for this trial) but perceived very little alteration to enſue in the thermoſcope, only that it ſeemed the ſpirit of wine in the ſtem did a little, and but a very little, ſubſide, which effect (though it had been much more manifeſt) I ſhould not have been ſurprized at, partly becauſe I found ſpirit of urine to have a like, or ſomewhat more conſiderable effect, and partly becauſe I remembered, what I elſewhere relate about the operation of the pure ſalt of human blood upon diſtilled water; which liquor I therefore make uſe of in theſe and many other experiments, becauſe in our common pump-water or well-water, and in moſt other common waters, I have obſerved a kind of common ſalt, which, though in very ſmall quantity, makes it apt to coagulate with, or precipitate, ſome kind of ſaline corpuſcles, whether more ſimple or more compounded. But before I quite diſmiſs the lately recited experiment, I muſt acknowledge, that I dare not acquieſce in it; ſince probably the effect of the ſpirit of blood would have been more conſiderable, if I had been furniſhed with a ſufficient quantity of it to pour into the water.

EXPERIMENT XI.

INTO a ſlender cylindrical vial we put filings of copper, more than enough to cover the bottom, and then pouring on ſome ſpirit of human blood, till it reached about an inch above the filings, we ſtopt the glaſs cloſe; and, as we expected, the menſtruum diſſolved ſome of the metal, and acquired upon it a deep ceruleous colour, which, by keeping the veſſel in a quiet place for ſome days, did by degrees diſappear, and left the liquor like water. And then the glaſs being unſtopt, there did, as was expected, appear a fine blue ſurface on the confines of the air and the liquor, in a minute of an hour or leſs; and this fine colour extending itſelf downwards, was in no long time diffuſed through the whole body of the liquor, and that ſo plentifully, as to render it almoſt opacous. But, though I kept the glaſs many days after well ſtopt, yet (whether it were, that there was too much air left in the vial, or for ſome other reaſon) the colour did not diſappear, as was expected, but continued very intenſe. This may confirm and diverſify an experiment related in the thirteenth title of the fourth part of the memoirs.

EXPERIMENT XII.

IT is not only upon copper, in its perfect metalline form, but by nature itſelf embrionated in, or blended with, ſtony matter, that our ſpirit of human blood did manifeſtly work: for having poured ſome upon well powdered *lapis Armenus*, the liquor did, even in the cold, and in no long time, (for it exceeded not a few hours) acquire a deep and lovely blue, almoſt like the ſolution of filings of crude copper made with the ſame menſtruum.

THE

POSTCRIPT.

AND here, Sir, I ſhall at length diſmiſs a ſubject, about which I now perceive I have already entertained you much longer, than at firſt I imagined. And yet, if I prevail with you, your trouble is not quite at an end; ſince I muſt exhort you to take the pains, for your own ſatisfaction and mine, to try over again ſuch of the foregoing experiments, as you ſhall judge likely to be of a contingent nature. For, though I hope you will do me the right to believe, that I have as faithfully as plainly delivered matters of fact, without being biaſſed by hypotheſes, or aiming at elegance, yet my exhortation may be reaſonable: for I have obſerved human blood to be a thing ſo diverſifiable, by various circumſtances, and eſpecially by the habitual conſtitution of the perſon, that bleeds, and his preſent condition at the very time of phlebotomy, that I dare not undertake, that every repeater of the like experiments with mine will always find the events to be juſt ſuch, as I have recited mine to have had. Nay, I dare not promiſe myſelf an exact uniformity of ſucceſſes, even when I myſelf ſhall reiterate ſome (of the nicer) of my own trials; eſpecially if I can do it, as I deſire, with greater quantities of blood than (for want of them) the firſt were made with.

TO the particulars already delivered in order to the hiſtory of human blood, I could now, Sir, add ſome others, if time and diſcretion would permit me to do it. For, as little cultivated as the ſubject has been, I found it not ſo barren, but that, whilſt I was delivering ſome trials concerning it, the conſideration of thoſe, and of the nature of the thing, ſuggeſted new ones to me. But it is high time I ſhould break off an appendix, that being but a rhapſody of the notes and other things, that have occured to me ſince the memoirs were written, may, I fear, ſeem already too prolix, as well as confuſed. I do not forget, that the two laſt ſubordinate titles of the fourth part of the memoirs concern the external and internal uſe of the ſpirit of blood in phyſic; and that therefore perchance it may be expected, that I ſhould here add ſome experiments or obſervations relating to thoſe titles. But I hope the lately mentioned reaſons, and my juſt backwardneſs to part with ſome of them, becauſe they are not yet finiſhed, will make you eaſily excuſe my laying them aſide; which I am like to do long, unleſs you and your learned friends ſhall peremptorily require them of me in a fitter ſeaſon than this, in which ſome occaſions, that I cannot diſpenſe with, call me off to other employments, and oblige me to leave a further inquiry into this ſubject to yourſelf, and thoſe able profeſſed phyſicians, who have, as well more obligation, as more ability than I, to purſue it effectually. This I may well hope, that you and they will do, ſince, upon a curſory review of a part only of what I have written, ſo many things ſprang up, even in my thoughts, as original trials, if I may ſo call them, or as other things fit to be further conſidered, that I perceived it would not be difficult to increaſe the appendix, by two ſorts of particulars; the one made up of *deſigned* experiments, that is, ſuch as have not yet been tried, and yet ſeem worthy to be ſo, (to which it is probable our excellent *Verulam*, would have given the title of *hiſtoria deſignata*:) the other ſhould conſiſt of ſuch trials, as I call ſuccedaneous experiments, that is, ſuch as I intended ſhould be made upon the blood of beaſts, in ſuch caſes and circumſtances, wherein the blood of men either cannot be had, or ought not to be procured. When I ſhall next have the happineſs to converſe with you, you may command a ſight of what I have drawn up of this kind. And, if GOD ſhall pleaſe to vouchſafe me health and conveniency, I may perhaps (for I muſt not abſolutely promiſe it) offer you what *addenda* have occured to me, as things not unfit to make way for a more copious, and leſs unaccurate ſcheme of titles, ſuch as thoſe, that in the firſt part (of the memoirs) are called *titles of the ſecond claſſis, or order*: for which ſcheme I was the rather invited to think it fit materials ſhould be by ſome body provided, becauſe ſecond thoughts made me ſenſible, that the particulars compiled in this ſmall book come far ſhort (as I lately acknowledged, and you will eaſily believe) of comprizing all, that ſhould and may be known of ſo noble and uſeful a ſubject, as I have ventured to treat of. And I will freely confeſs to you, on this occaſion, that, for my part, in the proſpect I have of the future advancement of human knowledge, I think moſt of thoſe virtuoſi, that now live, muſt content themſelves with the ſatiſfaction of having employed their intellects on worthy objects, and of having induſtriouſly endeavoured, by promoting uſeful knowledge, to glorify GOD and ſerve mankind. For, I preſume, that our enlightened poſterity will arrive at ſuch attainments, that the diſcoveries and performances, upon which the preſent age moſt values itſelf, will appear ſo eaſy, or ſo inconſiderable to them, that they will be tempted to wonder, that things to them ſo obvious, ſhould lye ſo long concealed to us, or be ſo much prized by us; whom they will, perhaps, look upon with ſome kind of diſdainful pity, unleſs they have either the equity to conſider, as well the ſmallneſs of our helps, as that of our attainments; or the generous gratitude to remember the difficulties this age ſurmounted, in breaking the ice, and ſmoothing the way for them, and thereby contributing to thoſe advantages, that have enabled them ſo much to ſurpaſs us. And ſince I ſcruple not to ſay this of thoſe ſhining wits, and happy inquirers, that illuſtrate and enoble this learned age, I hope you will not think, that I, who own myſelf to be more fit to celebrate than rival them, would diſſuade you from improving and ſurpaſſing the ſlight performances, that are, in this little tract, ſubmitted to your judgment by,

SIR,

Knightſbridge,
Dec. 22, 1683.

Your very humble ſervant.

EXPERIMENTS and CONSIDERATIONS
ABOUT THE
Poroſity of BODIES.
IN
TWO ESSAYS.

To the READER.

THE reader is to be advertiſed, not to expect, in the following eſſay, a regular, or ſo much as a coherent diſcourſe: for it was intended only as a collection of looſe experiments and obſervations, about the poroſity of the parts of bodies belonging (as chymiſts ſpeak) to the animal kingdom, and laid (not to ſay thrown) together, in order to what I had thoughts of offering towards an intelligible account of occult qualities. I am not ignorant, that even one of the moſt antient and famous of phyſicians hath ſaid, that a man's body is (almoſt) every where perſpirable. But I judged, that a doctrine of ſuch moment, and which divers things in the theory and practiſe of after phyſicians may make one think they either diſbelieved or diſregarded, did not deſerve to be ſlightly delivered, and in general terms; but to be more narrowly conſidered, and likewiſe made out by particular inſtances, whoſe appliableneſs and uſefulneſs to explain divers obſcure phœnomena may hereafter appear much greater, than, perchance at the firſt ſight, they will be thought.

And the foregoing advertiſement, with a light change, which, it is preſumed, the reader may eaſily make of himſelf, is to be extended to the eſſay tacked to this about the pores of ſolid bodies, and ſo may excuſe the abſence of a diſtinct preface to it.

Of the POROUSNESS of ANIMAL BODIES.

AS the moſt numerous part of the pores of bodies is too minute to be ſeen, ſo the contemplation of them has been thought too inconſiderable to be regarded. But when I conſider, how much moſt of the qualities of bodies, and conſequently their operations, depend upon the ſtructure of their minute, and ſingly inviſible particles, and that to this latent contexture, the bigneſs, the figure, and the collocation of the intervals and pores do neceſſarily concur with the ſize, ſhape and diſpoſition, or contrivance of the ſubſtantial parts, I cannot but think the doctrine of the ſmall pores of bodies of no ſmall importance to natural philoſophy. And I ſcarce doubt, but if ſuch little things had not eſcaped the ſight of our illuſtrious *Verulam*, he would have afforded a good porology (if I may ſo call it) a place, (and perhaps not the loweſt neither) among his *Deſiderata*.

And, though other employments and avocations hinder me from attempting to treat of this ſubject, as amply and particularly as it deſerveth, or even as I had deſigned in a ſcheme drawn divers years ſince, and ſeen by ſome virtuoſi; yet, not to leave a part of phyſicks, that ſeems to me ſo curious and important, altogether as uncultivated, as I found it, I ſhall preſent you as many of the notes I had drawn together, about this ſubject, as I can conveniently, (for I do not pretend to do it methodically) reduced to three heads: whereof the firſt, which will challenge to itſelf this preſent eſſay, is *The poroſity of animal bodies*, about which I ſhall not be ſollicitous to marſhal my obſervations, ſince they all conſpire to ſhew but this one thing; that the parts of animals, eſpecially whilſt theſe are alive, are furniſhed with numerous pores.

Those parts of the bodies of animals, wherein their poroſity may be beſt ſhewn, ſeem to be their membranes, or ſkins, the bones, the fleſh, and coagmentations of membranes, fleſh and juices; and therefore it would be proper enough to treat of theſe heads diſtinctly, and give inſtances of each of them in particular. But yet, I think, it will be more convenient to ſet down, in order, the principal fountains, whence the porouſneſs of the ſubſtances belonging to the animal kingdom (as the chymiſts ſpeak) may be derived, and to annex to each of theſe the experiments and obſervations, upon which I argue from it, and which it will be eaſy to refer, if that be thought fit, to this or that of the parts above-mentioned, (namely the membranes, bones, &c.) whereto they ſhall (reſpectively) appear the moſt properly to belong.

CHAP. I.

THE firſt thing, from which I will deduce the poroſity we have been ſpeaking of, is the frame or conſtitution of the ſtable parts of the bodies of animals. For the body of an animal being not a rude and indigeſted lump of matter, but a curious engine, admirably framed and contrived for the exerciſe of ſeveral functions, as nutrition, generation, ſenſation, and many differing local motions; it was neceſſary, that it ſhould be furniſhed with variety of diſſimilar, and organical parts, not only very ſkilfully, but very differingly contrived, congruous to the ſeveral uſes, for which they were deſigned, or, if you pleaſe, to the ſeveral functions they were to perform. And becauſe it will be eaſily granted, that the corpuſcles, that are ſkilfully brought together, for ſuch purpoſes, muſt be ſo contexed, as not to touch one another exactly every where, it will readily follow, that they muſt leave little intervals or pores between them; and that, conſidering the multitude of particles, that muſt go to the making up the body of the animal, and the great difference and variety, in point of bigneſs and figure of the corpuſcles, that are requiſite to contex ſuch differing parts, as membranes, fibres, bones, griſtles, ligaments, veins, arteries, nerves, &c. both the number and the variety of the pores cannot but be very great. This argument will be much confirmed, by what there will be occaſion to ſay further to the ſame purpoſe, in the eſſay touching the poroſity of even ſolid bodies. Wherefore I ſhall now proceed to the ſecond thing, whence we may derive that of animal ſubſtances.

CHAP. II.

THIS is afforded us, by conſidering the nutrition of animals: for there being continually a great waſte made of their ſubſtance, partly by the excluſion of viſible excrements, and partly by the avolation of inviſible ſteams, this great loſs muſt neceſſarily, from time to time, be repaired by the ſupplies afforded by nutrition, of which the beſt, if not the only intelligible way of giving an account, is, to conceive, that the alimental juice, prepared chiefly in the ſtomach, is impelled or attracted (for, to our preſent purpoſe, it matters not which) to the parts of the body, that are to be nouriſhed by it, and the corpuſcles of the juice inſinuate themſelves at thoſe pores they find commenſurate to their bigneſs and ſhape; and thoſe, that are moſt congruous, being aſſimilated, add to the ſubſtance of the part, wherein they ſettle, and ſo make amends for the conſumption of thoſe, that were loſt by that part before. This may be illuſtrated by what happens in plants, and eſpecially trees; in which, of the various corpuſcles, that are to be found in the liquors, that moiſten the earth, and are agitated by the heat of the ſun and the air, thoſe, that happen to be commenſurate to the pores of the root, are, by their intervention, impelled into it, or imbibed by it, and thence conveyed to the other parts of the tree, in the form of ſap, which paſſing through new ſtrainers, (whereby its corpuſcles are ſeparated and prepared, or fitted to be detained in ſeveral parts) receives the alterations requiſite to the being turned into wood, bark, leaves, bloſſom, fruit, &c. But to return to animals, our argument from their nutrition will be much confirmed, by conſidering, that in children, and in other young animals, that have not yet attained their due ſtature and bulk, the nutrition is ſo copious, as to amount to a continued augmentation: for as it is evident, that animals grow in all their parts, and each part according to all its dimenſions, in ſo much, that even the cavities of bones increaſe; ſo we cannot well conceive, how this can be done, unleſs the nutritive liquor be diſtributed through the whole body of the part, that is to be nouriſhed and augmented: and to this diſtribution it is requiſite, that the body abound with pores, into which the congruous particles of the juice may be intimately admitted, and, penetrating even into the innermoſt receſſes, may place or lodge themſelves in the manner, that is moſt convenient for the natural increaſe of the part. But the more particular declaration of this proceſs I leave to anatomiſts and phyſicians.

CHAP. III.

HAVING premiſed, once for all, that in this eſſay I often uſe the word ſkin, in the lax and popular ſenſe of it, without nicely diſtinguiſhing the *epidermis*, or *cuticula*, called in Engliſh the *ſcarf-ſkin*, from the *cutis* it inveſts, and ſticks cloſely to, I ſhall now proceed to another topic, whence the porouſneſs of animals may be argued;

namely, the great plenty of matter, that is daily carried off by ſweat, and inſenſible tranſpiration. For it is confeſſed, that ſweat is diſcharged at the pores of the ſkin; and, ſince there is no penetration of dimenſions, we may ſafely conclude, that the matter, that is not waſted by ſweat, or by any other ſenſible way of evacuation, muſt have ſmall pores, or out-lets in the ſkin, at which it may iſſue in the form of ſteams; though nothing hinders, but that inviſible effluvia alſo may evaporate at the ſame pores with the ſweat, though for want of plenty, or groſsneſs, or a fit diſpoſition in the ambient, thoſe effluvia be not, at the orifices of thoſe pores, brought into little drops, ſuch as thoſe of ſweat.

That therefore the ſkins of a multitude of animals, though they ſeem cloſe to the eye, may be porous, may (as we have been ſaying) be argued in many of them from their ſweating: but becauſe all of them have not been obſerved to ſweat, as is wont to be particularly affirmed of dogs, we ſhall add ſome other inſtances to make it probable.

We may, ſometimes, in the ſmooth ſkin of a living man diſcern pores, with good microſcopes; and, with one, that is none of the beſt, we may eaſily, on the inſide of gloves, which are made but of ſkins dreſſed, diſcern good ſtore of theſe little out-lets, ſometimes orderly enough ranged to make the ſight not unpleaſant. And though ſome of them may, I think be ſuſpected to have been made by the hairs, that grew on the ſkin before it was dreſſed, yet that greater numbers of them, than can be ſuppoſed to come from thence, are perforations that paſs quite through the leather, may, not improbably, be ſhewn, by the uſual practice of chymiſts, to purify quick-ſilver, by tying it up ſtrictly in a piece of kid's, or ſheep's leather, and then wringing it hard to force it out; by which means the lower ſurface of the leather will be covered with a mercurial dew or ſweat, which will fall down and fly out, as the pores happen to open this, or that way, in a thick ſhower of globules, leaving the droſs behind in the leather. And though when a man's ſkin is tanned, it is of a greater thickneſs than one would expect, and that, which I employed, ſeemed almoſt as thick as a buck-ſkin glove; yet having had the curioſity to try the ſame experiment with the ſkin of a man's arm, I found the quick-ſilver would be ſqueezed out at the pores of that alſo. It is not neceſſary, that I ſhould here enquire, whether the little holes, unperceived by the naked eye, at which the ſweat is diſcharged, and perhaps the matter, that the body looſes by inſenſible tranſpiration, gets out, be not, at leaſt moſt of them, the orifices of ſmall excretory veſſels, belonging to thoſe very numerous glandules, which the excellent anatomiſts *Steno* and *Malpighi* are ſaid to have diſcovered beneath the *cuticula*, and which, for their ſmallneſs and ſhape, have been called *glandulæ milliares*: I need not, I ſay, engage in this enquiry, ſince, according to this ingenious opinion alſo, the ſkin muſt be allowed a multitude of ſmall perforations or pores, and that is ſufficient for my purpoſe, from whenceſoever this poroſity proceeds in a man's ſkin. For the next obſervation will ſhew, that ſome membranes of animals may give paſſage to tranſpired matter, without being perforated by the excretory veſſels of glandules.

The membranes, or ſkins, under the ſhells of hens eggs, though they be very thin, are of a contexture very fine and cloſe, as may be confirmed by their reſiſting the ſharp corpuſcles of vinegar; and yet, that not only theſe ſkins, but the ſhells that cover them, are porous, may be inferred from the experiments I made of keeping them ſuſpended for a good while, and carefully counterpoiſed in good ſcales; for by theſe it appeared, that the eggs did, from time to time, manifeſtly loſe in weight; which could not reaſonably be imputed but to an inviſible tranſpiration, the rather, becauſe uſually in eggs, that have been kept long, there will be, at one end, a cavity, which is wont to increaſe with their age, and is made by the ſhrinking of the membrane from the ſhell, to accommodate itſelf to the diminiſhed quantity of matter, that remains to be involved by it.

When I conſider the plenty of matter, that is wont to be diſcharged daily by inſenſible perſpiration, eſpecially in healthful men, that exerciſe themſelves moderately, I cannot but think it probable, that the minute pores, that ſuffice for the carrying off ſo much matter, are very numerous, and are much more ſo than even, by the multitude of drops of ſweat, that ſerve to wet the ſkin, men are wont to imagine. For *Sanctorius*, in his excellent little tract *de medicina ſtatica*, affirms, that what is barely carried off by inſenſible tranſpiration does ordinarily amount to more, that is, diminiſhes more the weight of a man's body, than all the viſible excrements (whether groſs or liquid) put together, *Aph*. vi. He adds, if the meat and drink, taken in one day, amount to the weight of eight pound, the inſenſible tranſpiration ordinarily amounts to five pounds, or thereabouts: and elſewhere ſays, that ſometimes, in the ſpace of twenty-four hours, in the winter time, a healthy body may exhale fifty ounces, or more. And ſome trials, that I have carefully made upon myſelf, added to ſome others of a very curious as well as great prince, that made uſe of a like inſtrument, and did me the honour to acquaint me with the events, gave me no cauſe to reject *Sanctorius*'s obſervations, conſidering the difference, in point of heat, between the climate of *Italy*, where he writ, and that of *England*, where ours were made: only I fear there has been committed an overſight by thoſe many, that aſcribe all the decrement of weight, that is not referrible to the groſſer excrements, to what tranſpires at the pores of the viſible parts of the ſkin, without taking notice of that great plenty of ſteams, that is in expirations diſcharged through the windpipe by the lungs, and appear manifeſt to the eye itſelf, in froſty weather; though they may be preſumed to be then leſs copious, than thoſe inviſible ones, that are emitted in ſummer, when the ambient air is much warmer. But though I look upon the windpipe as the great chimney of the body, in compariſon of thoſe little chimnies (if I may ſo call them) in the ſkin, at which the matter, that is waſted by perſpiration, is emitted; yet the number of theſe little vents is ſo very great, that the fuliginous exhalations, that ſteal out at them, cannot but be very conſiderable. Beſides that thoſe, that are diſcharged at the *aſpera arteria*, do probably, at leaſt for the moſt part, iſſue out at the latent pores of the membranes, that inveſt the lungs; which membranes may be looked upon as external parts of the body, in reference to the air, though not in reference to our ſight. But, to return to our eggs, we may ſafely allow a very great evacuation to be made at the pores of the ſkin in man, who is a ſanguineous and hot animal, ſince we ſee, that even eggs, that are ſtill actually cold, tranſpire. And I elſewhere mention the copious tranſpiration even of frogs, that are always cold to the touch, and the decrement in weight of ſome animals, ſoon after they are ſtrangled or ſuffocated, when their vital heat being extinct, no more fumes are emitted by expirations at the wind-pipe. To which ſigns may be added the trivial experiment of holding, in warm weather, the palp of one's finger, as near as one can without contact, to ſome cold and ſolid ſmooth body, as to a piece of poliſhed ſteel or ſilver; for you will often times ſee this body preſently ſullied or over-caſt with the inviſible ſteams, that iſſue out of the pores of the finger, and are, by the cold and ſmooth ſurface of the body, condenſed into viſible ſteams, that do, as it were, cloud that ſurface, but, upon the removal of the finger, quickly fly off, and leave it bright again.

THE perviouſneſs of the ſkin outwards may, not improbably, be argued from the quickneſs wherewith ſome medicines take away ſome black and blue diſcolorations of the ſkin, that happen upon ſome lighter ſtroke, or other contuſions. For, ſince theſe preternatural and unſightly colours are wont, by phyſicians, to be imputed to ſome ſmall portions of blood, that, upon the contuſion, is forced out of the capillary veſſels, that lye beneath the ſurface of it, and, being extravaſated, are obliged to ſtagnate there; it ſeems very likely, that if a powerful medicine do quickly remove the diſcoloration, that work is performed by attenuating, and diſſolving, and agitating the matter, and diſpoſing it to tranſpire through the cutaneous pores, though perhaps, when it is thus changed, ſome part of it may be imbibed again by the capillary veſſels, and ſo, by the circulation, carried into the maſs of blood. Now, that there are medicines, that will ſpeedily work upon ſuch black and blue marks, the books and practice of phyſicians and chirurgeons will oblige us to admit. *Helmont* talks much of the great virtue of white briony root, in ſuch caſes; and a notable experiment made a while ago by a learned acquaintance of mine, in an odd caſe, did not give *Helmont* the lye. And I know an eminent perſon, who having, ſome while ſince, received a ſtroke by a kick of an horſe on his leg, a very threatning contuſion, which made the part look black and frightful, he was, in a few hours, cured of the pain of the hurt, and freed from the black part of the diſcoloration, by the bare application of the chopt leaves of hiſſop, mixed with freſh butter, into the form of a pultiſs.

NOR is it only the ſkin, that covers the viſible parts of the body, that we judge to be thus porous; but in the membranes, that inveſt the internal parts, we may reaſonably ſuppoſe both numerous and very various pores, according to the exigency of their peculiar and different functions or offices. For the two firſt cauſes of poroſity, mentioned in this eſſay, are as well applicable to the membranes, that cover the internal parts, as the liver, the ſpleen, &c. as to the external ſkin, or membrane, that covers the limbs; and, in ſome reſpects, the tranſpiration through ſuch pores ſeems more advantaged, than that through the pores of the ſurface of the body; ſince the parts that environ the ſpleen, liver, kidneys, &c. in man, are hot, in compariſon of the ambient air, and being alſo wet, which the air is not, the laxity of the pores of the internal parts is doubly befriended. And perhaps it may be allowable to conceive, both the ſkin, that covers the limbs, and the membranes, that inveſt the internal parts of the body, to be like worſted ſtockings, waſtcoats, &c. which, in their ordinary ſtate, have a kind of continuity, but, upon occaſion, can have their pores every way enlarged and ſtretched, in this or that manner, as the agents, that work on them determine them to be. This may be confirmed by what we manifeſtly ſee in the finer ſort of leather, as that of kid or lamb, and by the latent pores, that may be opened in ſheep's-leather, and man's leather, by the preſſure of included quick-ſilver.

THIS poroſity of a living man's ſkin, and other membranes, though internal ones, will the more eaſily be aſſented to, if it appear, that ſuch thick and groſs membranes, as the urinary bladders of dead animals, are porous, and penetrable even by water. This we tried, by putting ſome ſalt of tartar in a clean well dried bladder, (which ought to be afterwards tied up cloſe in the neck, leſt the effect ſhould be aſcribed to the moiſt air) and leaving the lower part of the bladder, as far as the ſalt reached, immerſed in common water, whoſe particles, by degrees, inſinuated themſelves into the pores of the bladder in plenty enough to reſolve the ſalt of tartar into a liquor. And, that it may not be ſaid, that the acrimony of the ſalt, by fretting the bladder, made way for the corpuſcles of the water, I ſhall add, that the experiment ſucceeded,

ceeded, but much more ſlowly, when we tried it with ſugar inſtead of ſalt of tartar. And there are ſome, who pretend, that certain ſyrups made this ſlovenly way, which they would have paſs for a ſecret, are very much preferable to thoſe made of common water.

THAT the films, that line the ſhells of eggs, are of a very cloſe texture, ſeems probable, as by other things, ſo by their reſiſting ſome liquors ſharp enough to corrode the ſhell; and yet, that ſuch membranes are pervious to liquors, that are none of the moſt ſubtile of all, we found by the enſuing experiment. This was made by taking an ordinary hen's egg, and keeping it for two or three days in diſtilled vinegar, or in ſtrong crude vinegar; for then taking it out of the liquor, and wiping it well, it was viſibly, and not inconſiderably, ſwelled, which I concluded to be from the ingreſs of ſome particles of the liquors at the pores of the ſkins, that inveſt the white of the egg; for we found nothing broken, though we made the trial more than once. And to be ſatisfied, that the manifeſt expanſion proceeded from ſome other cauſe, than the mere dilatation of the white, or yolk, or both, we compared the weight of the egg, after it was taken out and well wiped, with that, which had been taken before it was put into the menſtruum, and found the egg, notwithſtanding the loſs of the ſhell, to be conſiderably heavier, than it was before its immerſion.

I SHALL add, on this occaſion, that by a more unlikely way, than that newly recited, both the egg, ſhell and lining of an egg, may be penetrated: for, notwithſtanding the fine and cloſe contexture of the membranes, that inveſt the eggs, the *Chineſes* have a way of ſalting them in the ſhell, as I have been aſſured both by *Engliſh* and *Dutch* merchants trading to the *Eaſt-Indies*. And in one of the *Dutch* journals ſent by the council of *Batavia* to their principals in *Holland*, and intercepted by an *Engliſh* man of war, I met with divers accounts of great numbers of ſalted eggs, that were ſuch or ſuch a day of ſuch a month brought in by ſea to *Batavia* or other ports. Long after which time meeting with an ingenious phyſician, that lived in *Batavia*, I learned by enquiry from him, that it is very true, that ſuch eggs are frequently met with in thoſe parts; he having divers times eaten of them there, ſome, that he judged to have been either boiled or roaſted before they were ſalted, and others, that were raw, when they came to be dreſſed for him, but yet retained a briny taſte. And, though the merchants I enquired of could not tell me, what way the *Chineſe* employed to ſalt their eggs, without making them unfit for common uſe; yet, by a trial, made with clay and brine, in which I kept the eggs for a competent time, I was perſwaded, that it was poſſible the *Chineſe* ſhould have the art aſcribed to them: for upon the breaking of an egg coated with clay, after it had lain for a competent time in brine, I found its taſte conſiderably ſalt, but was, by I know not what accident, hindered from proſecuting the experiment and endeavouring to make it more practicable and uſeful.

I KNEW a phyſician of more learning than virtue, who, being tormented with a violent and obſtinate cholic of a peculiar kind, was wont to relieve himſelf by clyſters of ſack; though he uſually found, that, not long after he had taken any of them, they would make him giddy, and fuddle him, as he himſelf confeſſed to me. But, upon this inſtance I lay not much weight, and leſs upon what was anſwered me by a great chirurgeon, who having practiſed his art in the *Weſt-Indies*, and being aſked by me, whether he had not dreſſed wounds and ulcers with the recent juice of tobacco (a plant I uſe to keep growing in my garden for its excellent virtues in cuts, burns, and tumors,) and whether, if he employed it, he did not find it emetic; he told me, among other things, that having divers times dreſſed with this juice a ſmall ulcer in a woman's leg, the patient ſoon after the application would grow ſick, and have her ſtomach turned, or actually vomit. But, as I was ſaying, on this inſtance I lay no ſtreſs, becauſe the corpuſcles of the tobacco might probably enough get in at the ſmall orifices of ſome corroded veſſels, and ſo be conveyed inwards, rather by the help of the circulation of the blood, than on the account of the porouſneſs of the parts. And, therefore, I ſhall rather mention what has been related to me by an eminent phyſician of the famous college of *London*; namely, that he had divers times given himſelf a vomit, by a certain application of decocted tobacco to his wriſts and ſome other external parts: which brings into my mind, what is affirmed to have been obſerved in ſome children, that have ſcabbed heads, who have been made drunk by the application of clothes or ſpunges wetted in infuſion of tobacco, or of ſtrong liquors, and applied to the part affected: though, in this caſe, the inebriating particles may be ſuſpected to have got in, not at the meer pores, but rather at the orifices of the capillary veſſels, that were made acceſſible by ſuch little ſolutions of continuity, as are ſeldom wanting in ſcabby heads.

THAT children may be purged by outward applications, is aſſerted by ſome phyſicians; and an experienced perſon of that number has affirmed to me, that he can almoſt conſtantly do it by a plaiſter. But it is more conſiderable, what was related to me by an eminent virtuoſo, who being indiſpoſed to believe ſuch things, a while before he told me the ſtory, was deſired by a curious perſon to ſhew him his hand; which the relator having done, the other took it in his hand, which was moiſtened (as was afterwards confeſſed) with a kind of ſubtile chymical oil, but ſo ſlightly, that the relator ſcarce minded it; till ſome time after, when he found himſelf preſſed with a motion like that, which a purge would have given him; for the other thereupon ſmiling, my acquaintance began to ſuſpect what the matter might be, and was in a ſhort time purged four times, without griping, or other pain or diſcompoſure. But, to return to the porouſneſs of membranes, it may ſerve to make way for your admitting it, to obſerve, that though lute-ſtrings be but ropes of fibres (which are at leaſt the chief parts, that membranes conſiſt of) dead, cold and ſtiff; yet, when the lute is in tune, they will ſometimes in wet weather ſwell ſo forcibly, as with noiſe and violence to break; which proceeds from the copious ingreſs of moiſt vapours into their pores, whereby they are not only ſhortened, but, as I have tried in nice ſcales, made manifeſtly heavier.

The poroſity of the internal parts of animals by both the forementioned ways, (*viz.* of emiſſion and reception of corpuſcles,) may be confirmed by the things, that happen in ſome of the metaſtaſes or tranſlations (as the phyſicians call them) of the morbific matter in diſeaſed bodies. It is known to them, that are any thing converſant with hoſpitals, or the obſervations of phyſicians, that there do not ſeldom occur in diſeaſes ſudden removes of the matter, that cauſed them, from one part to another, according to the nature and functions of which, there may emerge a new diſeaſe, more or leſs dangerous than the former, as the invaded part is more or leſs noble. Thus oftentimes the matter, which in the ſanguiferous veſſels produced a fever, being diſcharged upon ſome internal parts of the head, produces a delirium or phrenitis; in the latter of which I have ſomewhat wondered to ſee the patient's water ſo like that of a perſon without a fever: the ſame febrile matter, either by a deviation of nature, or medicines improper or unſkilfully given, is diſcharged ſometimes upon the pleura, or membrane, that lines the ſides of the cheſt, ſometimes upon the throat, ſometimes upon the guts; and cauſes in the firſt caſe a pleuriſy, in the ſecond a ſquinancy, and in the third a flux for the moſt part dyſenterical. But, becauſe I ſuppoſe, that many, if not moſt, of theſe tranſlations of peccant humours are made by the help of the circulation of the blood, I forbore at the beginning of this ſection to ſpeak in general terms, when I mentioned them in reference to the porouſneſs of the internal parts of the body, and contented myſelf to intimate, that ſome of them may ſerve to confirm that poroſity.

This will not, perhaps, ſeem improbable, if we conſider, that it is in effect already proved by the ſame arguments, by which we have ſhewn, that both the ſkin and the internal membranes are furniſhed with pores, permeable by particles, whoſe ſhape and ſize are correſpondent to them. For we may thence probably deduce, that when a morbific matter, whether in the form of liquor, or of exhalations, chances to have corpuſcles ſuited to the pores of this or that part of the body, it may, by a concourſe of circumſtances, be determined to invade it, and ſo diſlodge from its former receptacle, and excite diſorders in the part it removes to.

CHAP. IV.

Another thing, whence the poroſity of animals may be argued, is their taking in of effluvia from without: for theſe cannot get into the internal parts of the body, to perform their operations there, without penetrating the ſkin, and conſequently entering the pores of it.

Now, that things outwardly applied to the body may, without wounding the ſkin, be conveyed to the internal parts, there are many things, that argue.

And firſt, it has been obſerved in ſome perſons, (for all are not equally diſpoſed to admit the action of particular poiſons) that cantharides being externally applied by chirurgeons or phyſicians, may ſoon, and before they break the ſkin, produce great diſorders in the urinary paſſages, and ſometimes cauſe bloody water. And, I remember, that having once had a bliſtering plaiſter applied by a ſkilful chirurgeon between my ſhoulders, though I knew not, that there were any cantharides at all mixed with the other ingredients, yet it gave me about the neck of my bladder one of the ſenſibleſt pains I had ever felt, and forced me to ſend for help at a very unſeaſonable time of night.

The porouſneſs of the ſkin may be alſo argued from divers of the effects, even of milder plaiſters. For, though ſome plaiſters may operate, as they cloſely ſtick to the ſkin, and hinder perſpiration from within, and fence the part from the external cold; yet, it will ſcarce be denied, that many of them have notable effects upon other accounts, whereof none is ſo likely and conſiderable, as the copious ingreſs of the corpuſcles of the plaiſter, that enter at the pores of the ſkin, and being once got in, act according to their reſpective natures and virtues. The like may be ſaid of ointments, whoſe operations, eſpecially on children (whoſe ſkin is ordinarily more ſoft and lax) are ſometimes very notable. And I have known conſiderable things performed by them, in an internal diſeaſe of grown men, where I ſhould ſcarce have expected a vegetable ointment ſhould perform ſo much: I ſay, a vegetable ointment, for it it is vulgarly known, that by mercurial ointments ſalivation may be excited; and ſometimes, againſt the phyſician's will, the corpuſcles of the quickſilver get ſo far into the body, that he is not able to get them out again.

What we lately ſaid of plaiſters may be applied to thoſe, that phyſicians call *pericarpia*, or wriſt-bands; the better ſort of which, though ſometimes ineffectual, are oftentimes ſucceſsful in ſtopping fits of agues, as I have frequently found in a mixture, elſewhere mentioned, of currans, hops, bay-ſalt well beaten together; by which, by God's bleſſing, many, and I among others, have been freed from ſimple tertians, and either double tertians or quotidians.

The argument of the poroſity of animals, drawn from thoſe things, that get in through their ſkins without breaking or wounding them, may be much ſtrengthned, if it can be made appear, that thoſe phyſicians do not deceive us, who aſcribe ſenſible operations and virtues to things externally applied in ſo looſe a way, that they do not ſo much as ſtick to the skin, or perhaps immediately touch it; ſuch as ſome call *Periapta* and *Appenſa*; divers of which are beſt known among us by the name of amulets; ſuch as are the quills containing quickſilver or arſenick, that ſome hang about their necks, and wear under their ſhirts, againſt the plague and other contagious diſeaſes; and the bloodſtones, that others wear againſt hæmorrhages; and the ſtone, which the women uſe in the *Eaſt-Indies*, for a quite contrary effect, in *obſtructione menſium*. That many of theſe external medicines anſwer not the promiſes of thoſe, that extol them, having ſome of them no ſenſible operation at all, and others no conſiderable one, experience has aſſured judicious obſervers; but that ſome of them, eſpecially on ſome patients, may have conſiderable, not to ſay admirable, operations, I confeſs, myſelf, by other motives, as well as authority, to be perſuaded. Having been one ſummer frequently ſubject to bleed at the noſe, and reduced to employ ſeveral remedies to check that diſtemper; that, which I found the moſt effectual to ſtanch the blood, was ſome moſs of a dead man's ſkull (ſent for a preſent out of *Ireland*, where it is far leſs rare, than in moſt other countries) though it did but touch my ſkin, till the herb was a little warmed by it. And, though I remember not, that I have known any great matter done to ſtop hæmorrhages by the bare outward application of other blood-ſtones; yet, of one, that looked almoſt like an agate, I admired the effects, eſpecially upon a young and extraordinary ſanguin perſon. To which I ſhall add a memorable thing, communicated to the experienced *Zwelfer* by the chief phyſician of the ſtates of *Moravia*: for this learned man, whom he extols for a great phyſician and philoſopher, aſſures him, that having prepared ſome trochiſcks of toads, according to *Helmont*'s way, (which I remember I alſo was ſollicitous to prepare, but had not occaſion to make trial of their virtue,) he not only found, that, being worn as amulets, they preſerved him and all his domeſtics and friends from the plague (though he daily viſited the infected) but that having cauſed theſe trochiſcks to be put upon the plague ſores of ſeveral perſons, none of them died, but the venom of the peſtilential carbuncles was thereby ſo weakened, that the ulcers were afterward eaſily cured by vulgar remedies.

If one would ſee this paſſage at large, he may find it at the end of the eſſay.

And now, as to the difficulty, which I acknowledge not to be ſmall, to conceive, how bodies, actually cold, can emit effluvia, capable of penetrating (without moiſtening it) a membrane of ſo cloſe a contexture, as a man's ſkin; I ſuppoſe it will be much leſſened in the objector's opinion, by what he will meet with hereafter about the pores of bodies, and the figures of corpuſcles. For, ſuppoſing theſe to be congruous, it will not ſeem incredible, that the effluvia of amulets ſhould, in tract of time, get paſſage through the pores of the ſkin of a living body. And, to make this the more probable, I will give an inſtance in the ſkin of a dead animal. And, becauſe this requires a liquor I much employ in theſe trials about porology, though I have many years ſince, in another tract, taught how to make it for another purpoſe; yet I ſhall here repeat, that it is made by exactly mingling flower of brimſtone, powdered ſal armoniac, and good quick-lime, in equal quantities, ſave that, if the quick-lime be not very dry and good, a fourth or fifth part muſt be ſuperadded; for theſe being nimbly mixed, and diſtilled by degrees of fire in a retort, till the ſand be at length brought to be almoſt red hot, there will come over a ſmoking ſpirit, which muſt be kept very carefully ſtopt, and which, for diſtinction's ſake, I alſo uſe to call the permeating menſtruum or liquor, and its expirations the penetrant, or permeating fumes.

And now you will eaſily underſtand the experiment I was about to mention, which was this; we took a very clean piece of poliſhed copper, in want of which one of ſilver will ſerve the turn, and having lapt it up in a piece of either lamb's or ſheep's leather, ſo that it was every way incloſed, we then held it over the orifice of the vial, that contained the ſpirit, at a pretty diſtance from the liquor, whoſe fumes, nevertheleſs, did quickly (perhaps in a minute of an hour or leſs) pervade the pores of the leather, and operate upon the included metal, as appeared by the deep and laſting tincture it had given to the lower ſurface of it, though the interpoſed leather itſelf was not deprived of its whiteneſs, nor at all ſenſibly diſcoloured; however, it ſmelt of the ſulphureous ſteams, that had invaded it. And, if I miſremember not, the ſame experiment ſucceeded, though ſomewhat more ſlowly, when a double leather was interpoſed between the fumes and a new piece of copper coin. This will be thought the leſs ſtrange, when I ſhall come to ſome other inſtances of the penetrancy of theſe ſpirits. In the mean while I leave it to be conſidered, whether this may not ſuggeſt ſome conjecture at that ſtrange phænomenon, which is recorded by authors of good repute, that ſometimes in great thunders the lightening, among other operations, has been found to have manifeſtly diſcoloured men's money, without burning the purſes or pockets wherein it lay. For in our experiment, the ſteams, that in a trice pervaded the leather, the moſt uſual matter whereof purſes are made, were ſulphureous, as the ſmell argues, that thoſe, which accompany the fulmen, are wont to be; and whereas theſe, when they invade bodies, are uſually very hot, ours operated, when the liquor, that emitted them, was actually cold. And, if it be ſaid, that ſometimes their money has been found diſcoloured in their pockets, who were not ſtruck by the fulmen, but had it only paſs near them, it may be objected, that though the intire body, whether fluid or ſolid, if there be any of this latter kind, that is in Latin called fulmen (for our Engliſh word, thunderbolt, ſeems not ſo applicable to a fluid) did not touch them, yet it might ſcatter ſteams enough round about it, to cauſe the phænomenon. For confirmation of which I ſhall take notice, that a conſiderable perſon of my acquaintance having had the curioſity to aſcend a burning mountain in *America*, till the ſulphureous ſteams grew too offenſive to him, he told me, that, among other operations he obſerved them to have upon him, one was, that he found the money he had about him turned of a black and dirty colour, ſuch as I have obſerved our ſulphureous ſteams often give both to copper and to ſilver coins. But whether or no our ſpirits will juſtify the conjecture they invited me to mention, at leaſt their ſo eaſily pervading the ſkin of a dead animal may make it probable, that the ſkin of a living man may be eaſily penetrated by external ſteams, whoſe approach the eye does not perceive, and whoſe operations, though not inconſiderable, may therefore be unſuſpected. I leave to phyſicians to conſider, what uſe may be made of this obſervation, in reference to the propagation of contagious diſeaſes by the contact of infected air, diſtinct from the reſpiration of it, and by the penetration of the ſteams, that, iſſuing from divers bodies, invade the ſkin, and may perhaps be capable of operations, either hurtful or friendly, that are not uſually ſuſpected to proceed from ſuch cauſes, and are therefore miſaſcribed to others. And, on this occaſion, it will not be impertinent to add, that by hanging up ſheep's leather or lamb's leather in the free air, the vapours of it would ſo inſinuate themſelves into the pores in wet weather, that a moderate degree of moiſture in the air would add to it a not inconſiderable weight, of which dry weather, whether hot or cold, would deprive it.

CHAP. V.

I MUST not in this place omit ſome inſtances very proper to manifeſt the penetrableneſs of membranes to fumes themſelves, if they be ſubtile enough for their pores, or correſpondent enough to them.

AMONG the obſervations publiſhed by phyſicians, I have met with ſome, by which it appears, that cantharides may have great effects upon the internal parts of the body, though they do not ſo much as touch the ſkin, but are placed at ſome diſtance from it, ſo that their effluvia muſt be tranſmitted through other bodies before they can penetrate that. The learned *Michael Paſchalius* mentions a chirurgeon, who was twice brought to void much blood with his urine, by ſome Spaniſh flies, that he carried about in a purſe or bag. And another doctor of note relates of another perſon, that came to complain to him, that he piſſed blood, having carried about with him cantharides, though in his pocket; and adds, that a like caſe was recounted to him by *Helidæus*, whom he calls an eminent *Bolognian* phyſician.

Schenkii obſervationum, lib. 7. obſ. 37.

WE ſee, that in linnen cloth, the finer and more ſlender the threads are, the cloſer and leſs porous, *cæteris paribus*, the linnen is; by analogy to which one may eſteem the thin film, that lines the ſhell of an egg, to be of an exceeding cloſe contexture; and yet, that even this film is not impervious to ſome fumes, I have found by the following trial.

TO make this, we ſlowly and warily picked off a ſufficient part of the ſhell of an hen's egg from the ſkin, that lay juſt beneath it, and is wont to ſtick ſo cloſe to it, that their ſeparation, without injuring the membrane, is not eaſy. In this ſkin, being wiped, we wrapt up a flat piece of copper, whoſe ſurface was made bright, that the change of colour might be the better ſeen; and having kept this covered bit of plate over the fumes of our ſmoking liquor, lately mentioned, for a minute or two by our gueſs, we unfolded the ſkin, and found, as we expected, that the lower ſurface of the copper, which was it, that had been held over the fumes, was turned of a very dark colour, which manifeſted, that even ſo fine and cloſely contexed a membrane was not only, as we have formerly ſhewn, penetrable by liquors, but readily pervious to our ſulphureous exhalations, though theſe were probably but faintly emitted, ſince the liquor they came from was then actually cold. But, in making the trial, it is fit to hold (as we did in that newly recited) the membrane againſt the light, to ſee if it be intire, and have eſcaped all thoſe little lacerations, that are hardly avoidable in ſevering it from the ſhell it ſticks ſo cloſe to. If this caution be neglected, it is eaſy to be impoſed on, by overlooking ſome little holes, that are not eaſily diſcerned when one looks down upon the ſkin, and yet may be ſufficient to make the experiment deceitful: but, though, when it is well made, it is a notable confirmation of the doctrine endeavoured to be eſtabliſhed in this paper, yet, I ſhall now ſubjoin a more conſiderable inſtance to the ſame purpoſe.

THE porouſneſs of the internal membranes of the body will be more eaſily granted, if it be conſidered, that either the liquors, or the moiſt exhalations, whoſe action is promoted by the natural heat of the parts, keeps them conſtantly wet or moiſt, and thereby renders them more lax, and more penetrable by ſubtle ſpirits or other corpuſcles. In favour of this reflection I made the following experiment. We took a piece of a dried urinary bladder, which was judged to have been a calf's; and having lapt it about a new piece of ſilver coin, ſo that the bladder was ſingle, where it covered the lower ſide of the piece, we kept it for divers minutes, by gueſs, over the ſpirituous fumes of our often mentioned permeating liquor, but could not perceive, that the coin was thereby at all affected or tarniſhed; whence we concluded, that the pores of the dry bladder were too cloſe and narrow, to give paſſage to the expirations of the menſtruum. But preſuming, that moiſture would ſomewhat relax them, with another piece of the ſame bladder, made limber, by being a little wetted in common water, we lapt up another like piece of new coin, as we had done the former, and kept it at the ſame diſtance, as before, from the liquor, but not for ſo long a time: for after about two minutes, by gueſs, we removed and took out the piece, and, as we expected, found much of its lower ſurface (that regarded the liquor) deeply diſcoloured. Which experiment will not only juſtify, what I lately ſaid, of the greater laxity of moiſt than of dry membranes, but will be thought no mean confirmation of what is in this eſſay delivered about the poroſity of membranes; ſince the urinary bladder does, as anatomiſts well know, conſiſt of more than one membrane, though they ſtick ſo cloſe together, as to appear but one to the eye. And this bladder was ſpeedily penetrated by the fumes, that our liquor emitted in exceeding cold and froſty weather, though the bladder itſelf was not in the warm body of the live animal, but had been ſo long kept dried and cold, that probably the moiſture it introduced in ſcarce one minute of an hour could not reſtore it to the laxity it had, whilſt it was a part of the living calf.

ONE of the notableſt inſtances I ever met with of the poroſity of the internal membranes of the human body, was afforded me by that *Britiſh* nobleman, of whom our famous *Harvey* tells a memorable, not to ſay matchleſs ſtory. This gentleman, having in his youth, by an accident, which that doctor relates, had a great and laſting perforation made in his thorax, at which the motion of his heart could be directly perceived, did not only out-live the accident, but grew a ſtrong and ſomewhat corpulent man; and ſo robuſt, as well as gallant, that he afterwards was a ſoldier, and had the honour to command a body of an army for the king. This earl of *Mount-Alexander* (for that was his laſt title) having married one of my neareſt kinſwomen, and having been told, that I was very deſirous to ſee, what I had heard ſuch ſtrange things of, very obligingly came, at a fit time to give me that ſatisfaction. In order to which he removed that, which covered the wide orifice of his hurt, and gave me the opportunity of looking into his thorax, and of diſcerning there the motions of the cone, as they call it, or mucro of the heart. But theſe things I mention but upon the bye, and becauſe of the ſtrangeneſs of the fact; the thing I principally intended relates to my preſent argument. Having then made ſeveral inquiries fit for my purpoſe, his lordſhip told me, that, when he did, as he was wont to do from time to time, (though not every day) inject with a ſyringe ſome actually warm medicated liquor into his thorax, to cleanſe and cheriſh the parts, he ſhould quickly and plainly find in his mouth the taſte and ſmell of the drugs, wherewith the liquor had been impregnated. And I further learned, that, whereas he conſtantly wore, upon the uncloſed part of his cheſt, a ſilken quilt ſtuffed with aromatic and odoriferous powders, to defend the neighbouring parts and keep them warm; when he came, as he uſed to do after ſome weeks, to employ a new quilt, the fragrant effluvia of it would mingle with his breath in expiration, and very ſenſibly perfume it, not, as I declared I ſuſpected, upon the ſcore of the pleaſing exhalations, that might get up between his cloaths and his body, but that got into the organs of reſpiration, and came out with his breath at his mouth, as was confirmed to me by a grave and judicious ſtateſman, that happened to be then preſent, and knew this general very well. Other circumſtances I might add, but that I dare not truſt my memory for them, and unhappily loſt the paper, wherein the oddneſs of the things invited me to ſet them down, for fear of forgetting them.

THAT part of this narrative, which relates to injections, may be much confirmed by what is delivered by *Galen* himſelf, who ſays, that mulſum, or honeyed water, being injected at the orifice of wounds penetrating into the cavity of the thorax, has been obſerved to be in part received into the lungs, and diſcharged out of the *Aſpera Arteria* by coughing. And this he mentions, as a known thing, employing it as a medium, whereby to prove another.

THE mention, that has been made of the poroſity of membranes, brings into my mind, what I once obſerved at the diſſection, made by ſome phyſicians and anatomiſts, of a luſty ſoldier, that was hanged for I know not what crime. This man, though otherwiſe young and ſound, was obſerved to have been long moleſted with what they call a ſhort dry cough, which made us expect to find ſomething much amiſs in his lungs. But meeting with nothing there, we were at a loſs for the cauſe of this cough, till coming to conſider the internal part of the cheſt, we perceived ſomething on one of the ſides, by tracing of which we diſcovered, that between the pleura and the ſubſtance of the intercoſtal muſcles there was lodged a certain matter, of the breadth of a ſilver crown-piece, or thereabouts, of a roundiſh figure, and of the conſiſtence and almoſt colour of new, ſoft cheeſe; which odd ſtuff was concluded to have been the remains of ſome ill cured pleuriſy, and to have tranſmitted through the pores of the pleura, though that be a very cloſe membrane, ſome noxious effluvia, which ever and anon irritated the lungs into an irregular and troubleſome motion, and ſo produced the cough the malefactor had been moleſted with.

CHAP.

CHAP. VI.

I Am well aware, that it is far leſs difficult, to prove the permeableneſs of ſingle membranes, than that of ſuch a part of the body, as ſeems to be an aggregate of ſeveral parts, which, in regard of their cloſe adheſion, are looked upon but as one part, to which, on that account, men commonly give a diſtinct name: but yet there are ſome phænomena, that ſeem to argue, that even ſuch compounded or reſulting parts, if I may ſo call them, are not deſtitute of pores; which, whether they be not ſome of them the orifices of exceeding ſlender and therefore unobſerved capillary veſſels, I muſt not now ſtay to inquire.

When the cavity of the abdomen in thoſe hydropical perſons, that are troubled with an aſcites, is filled with water, or rather with a liquor, that I have found to be much more viſcous, it juſtly appears ſtrange, that by an hydragogue, or ſome appropriated purging medicine, great quantities of this groſs liquor ſhould in a ſhort time be carried off by ſiege, and perhaps alſo by urine; though to get into the cavity of the guts, or that of either of the kidneys, it ſeems neceſſary, that it permeate the tunicles, and other component parts, of the viſcera it gets into.

I know not, whether I may, on this occaſion, take notice of what phyſicians obſerve to occur now and then in empyema's, that follow ill conditioned pleuriſies. For it has ſeveral times been obſerved, that upon the burſting of ſuch impoſthumes into the cavity of the cheſt, the purulent matter hath been voided by ſiege and urine. I heſitate, as I was ſaying, whether I ſhould alledge this phænomenon, as a proof of what I now contend for, till it be determined, whether this metaſtaſis be made by tranſudation properly ſo called, or by the ingreſs of the pus into the imperfectly cloſed orifices of the veſſels of the lungs; where being once admitted and mingled with the blood, they may with this circulating liquor arrive at the kidneys, or any other parts fitted to make a ſecretion of this heterogeneous matter.

But whatever be the reaſon or manner of it, we find, that the lungs do ſometimes oddly convey things to diſtant parts of the body. And if I may here mention a thing, *cui bonos præfationis eſt*, I ſhall add, that I have ſeveral times obſerved in myſelf, that when I had been an actor, or an aſſiſtant, in the diſſection of a living dog, eſpecially if his blood or body were rankly ſcented, I ſhould divers hours after plainly find that odour in the excrements I voided by ſiege.

A famous chirurgeon and anatomiſt relates, that one, who was very ill of a dropſy judged to ariſe from a ſcirrhus of the ſpleen, coming to aſk his counſel and aſſiſtance, though he judged the patient's caſe deſperate, yet to content him, he ordered him to dip a very large ſpunge in good quicklime water, and having ſqueezed out the ſuperfluous liquor, to bind it upon the region of the ſpleen, only ſhifting it from time to time. He adds, that after ſome months he was much ſurprized to receive a viſit from this patient, with ſolemn thanks for his recovery; the outward medicine having, it ſeems, reſolved the ſcirrhus, and concurred with nature to evacuate the hydropical humour. For the reſolution of which hard tumour it ſeems neceſſary, that the ſanative corpuſcles of the external remedy ſhould at length penetrate, not only the epidermis, and the true cutis, but the muſcles themſelves of the abdomen, and ſome other interpoſed parts.

These inſtances may be ſtrengthened by an eminent obſervation of *Galen*, who takes notice, that bones being ſometimes broken, without piercing the ſkin, that covers the part they belong to, when the callus is making, and the broken parts of the bone begin to be conglutinated together, a portion of that blood, which had flowed to the part affected, is carried to the ſkin, and permeates that, ſo as to wet and foul the dreſſings or bandages, that are kept upon the limb affected by the fracture.

CHAP. VII.

Bones, horns, and parts of the like ſubſtance, being thoſe, that are granted to be the moſt ſolid of the bodies of animals, I come, in the laſt place, to ſhew by particular experiments, that theſe alſo have their pores: I ſay, by particular experiments, becauſe, in a general way, their poroſity has been already proved, by the ſame arguments, from their original texture, nutrition, augmentation, *&c.* that have been employed to manifeſt the porouſneſs of animal ſubſtances in general.

That the nails of men, as well as their ſkins, are porous, may be gathered from their being eaſily and permanently tinged with divers metalline ſolutions, and particularly with thoſe of ſilver in *aqua fortis*, and gold in *aqua regia*; the former of which ſolutions, though cold, will but too eaſily tinge the ſkin and nails it chances to touch, and makes ſome little ſtay upon, with a dark and blackiſh colour; which I found not, that I could waſh out with water, or, even with a far more penetrating and abſterſive liquor. The like durableneſs I found in the purple ſpots, that I ſometimes purpoſely made on my nails by letting ſome little drops of the ſolution of gold in *aqua regia* dry upon them, which I now and then did, to obſerve the way of the nails growth; for if the ſtain were made near the root of the nail, it would be ſtill, though very ſlowly, thruſt on by the new matter, till, after ſome weeks, it arrived to the further end of the nail, and was fit to be pared off with it. But this only upon the by. It is more to our purpoſe to take notice, that, though the menſtruums employed in the recited experiments be of themſelves very acid and corroſive, yet they are ſo changed by the metals they have diſſolved, that they are acid no more; the ſolution of ſilver being rather extremely bitter, and that of gold of a kind of ſtiptic taſte, almoſt like that, which ſloes growing in the hedges are wont to be of.

Ivory is a thing too well known to need to be deſcribed. And, ſince it is generally looked upon (for I have had no opportunity to compare it with the bones) as the ſolideſt part of the vaſteſt of terreſtrial animals, experiments proving its poroſity, will be ſtrong preſumptions for that of the hardeſt parts of other animals. And the porouſneſs of ivory may be argued from the ſeveral ways of dying it with permanent colours; for in theſe colorations the tinctures, that make them, muſt penetrate into, and be lodged in the ſubſtance of the ivory, eſpecially when the ſubſtance remains ſmooth and glaſſy, as I have divers times made it do, when I employed fit menſtruums and metalline pigments. The ſolution I formerly mentioned of ſilver in *aqua fortis*, being laid upon ivory, will ſoon give it a dark and blackiſh ſtain, which is not, that I have found, to be waſhed off. I remember alſo, that I many years ſince taught ſome ingenious artificers, to adorn ivory with a fine purple colour, by moiſtening it with, and ſuffering leiſurely to dry on it a ſolution of gold made in *aqua regia*, and, if occaſion required, allayed with water; nor needs either of theſe ſolutions be applied hot, any more than the ivory needs to be heated. Both which circumſtances favour the porouſneſs of the ſolid body.

Copper diſſolved in *aqua fortis* ſtains ivory with a bluiſh colour, as I have ſometimes ſeen in the hafts of knives, about whoſe coloration, nevertheleſs, another way is alſo employed. But I remember, that, without making uſe of any acid or corroſive menſtruum, I have even in the cold ſtained ivory with a fine and permanent blue like a turquois, by ſuffering to dry upon it as deep a ſolution, as I could make, of crude copper, in an urinous ſpirit, as that of ſal armoniac.

But, now to return to bones, their growth, in all their dimenſions, does, as I lately noted, argue their poroſity; and the marrow, that is found in the great hollow bones, whether it nouriſh them or no, muſt itſelf be ſupplied by ſome alimental juice, that ſoaks, or otherways penetrates, into the cavities, that contain it.

Nor does it ſeem at all improbable, that blood itſelf may through ſmall veſſels be conveyed into the very ſubſtance of the bone, ſo as that the veſſels reach at leaſt a little way in it, though perhaps the liquor they carry may afterwards, by imbibition, be brought to the more internal parts of the bone. For not to urge, that we manifeſtly ſee, that on each ſide of the lower jaw nature has been careful to perforate the bones, and make a channel in the ſubſtance of it; which channel receives not only a larger nerve, but a vein and artery, to bring in and carry back blood for the nouriſhment of the teeth, by diſtinct ſprigs ſent from the great branch to the particular teeth: not to urge this, I ſay, (which I mention but to ſhew, that the opinion lately propoſed is agreeable to a known practice of nature) I have been aſſured by eminent anatomiſts, whom I purpoſely conſulted, that they have obſerved blood-veſſels to enter a great way into the ſubſtance of the larger bones; and one of them affirmed, that he had traced a veſſel even to the great cavity of the bone: which I the leſs ſcrupled to admit, becauſe it has been obſerved, that in younger animals the cavity is in great part furniſhed with blood, as well as marrow, and in thoſe larger pores, whereof many are found in the more ſpungy ſubſtance of divers bones, blood has been obſerved to have been lodged, as alſo in the ſpungy part of the ſkull, that lies between the two tables, as I have been aſſured by ſkilful eye-witneſſes.

The blackneſs alſo, that bones acquire, when put into a competent heat, and a peculiar kind of fatneſs, which they may by heat be made to afford, ſhew, that they harbour, even in their internal parts, ſtore of unctuous particles, ſeparable from the ſolid ſubſtance, (which ſtill retains its ſhape and continues ſolid) in whoſe pores they may thereby be argued to have been lodged. The lightneſs of bones, even when their cavity is acceſſible to air and water, is alſo a great ſign of their poroſity: and ſo is their being corroded by tinging liquors, if they be penetrative and well applied. I know not, whether I ſhould add on this occaſion, that having taken calcined and pulverized bones, ſuch as we uſed to make our cupels of, and, after having given them a good heat, kept them for ſome time in the air, but in a well covered place, I found the imbibed moiſture of the air to have manifeſtly increaſed their weight; and that, I alſo obſerved, in a curious ſkeleton, where the bones were kept together by wires, inſtead of other ligaments, that though I kept it in a well covered place, not far from a kitchen fire, yet in very moiſt weather the bones ſeemed to ſwell, ſince thoſe joints, that were eaſy to be bent in dry weather, and that after ſeveral manners, would grow ſtiff and refractory, and indiſpoſed to be put into ſuch motions, when the weather was conſiderably wet. Theſe particulars (as I was ſaying) I am ſomewhat doubtful, whether I ſhould here inſert, becauſe one may ſuſpect the phænomena may proceed rather from ſomewhat elſe, than the imbibed moiſture of the air; and yet, I would not omit to mention theſe obſervations, becauſe I do not yet ſee any cauſe, to which they may more probably (or indeed ſo probably) be aſſigned.

And, on this occaſion, I ſhall ſubjoin ſome obſervations made on large and ſolid ox bones, which in one of my note books I find thus regiſtred, *Nov.* 15. We weighed two [entire or unbroken] marrow bones, and found the one to weigh ℥xxix. + ʒſs. and the other ℥xxiv. + ʒiv. + 30 gr. *Nov.* 24. the former weighed ℥xxix. + ʒvi. and the latter ℥xxv. + ʒi. + 30 gr. *Dec.* 28. the former weighed ℥xxix. + ʒiij. 55 gr, and the latter ℥xxiv. + ʒvij. + 39 gr. *June* 7. of the following year, the former weighed ℥xxix. + ʒij. and the latter ℥xxiv. + ʒvij. By which obſervations, purpoſely made at differing times of the year, and in very good ſcales, it ſeems, that bones do plentifully enough imbibe the exhalations of the air, and emit them again, together with ſome of their own, according as the ambient happens to be diſpoſed. And theſe alterations argue the bones to abound with pores, ſince the external ſteams muſt have pores to receive them, and the effluvia muſt, upon their receſs, leave pores behind them.

I CONFESS, that to think (as, with ſome anatomiſts, I lately ſeemed to do) that bones themſelves admit into their ſubſtance veſſels capable of conveying a nutritive liquor, we muſt ſuppoſe thoſe veſſels extremely ſlender: but, that it is not only poſſible, but ſomewhat credible there may be ſuch, I am induced to think by what is known to happen in that diſeaſe, which, from the country it moſt infeſts, is called the *Plica Polonica.* For, though one would think, that the hairs of men are much too ſlender to have cavities in them capable of viſible liquors; and though I have found it very difficult, even with a good microſcope, to perceive any cavities in the hair of a man tranſverſly cut; yet, not only ſome other writers of good note, but the judicious *Sennertus* himſelf, deliver, that in this diſeaſe (of which he particularly treats) it has been obſerved, that if the patients cauſe the intangled hair to be cut, as they ſometimes do, by reaſon of its naſtineſs or unſlightlineſs, they are not only thereby endangered, but ſometimes the ſingle hairs will actually bleed, where the ends have been cut off; ſo that ſo thick a liquor, as blood, may be conveyed through veſſels, that can at moſt be but in a proper ſenſe capillary, and muſt be far leſs than hairs, if their perforations be like thoſe, by which many plants have their nouriſhment conveyed to them, or ſuch as are obvious in divers canes, which, being cut quite through tranſverſly, diſcover a multitude of diſtinct pores, that, by ſome experiments one may be induced to gueſs, reach all along, and make the cane like a cylindrical bundle of minute pipes; or rather a multitude of ſmall cavities, that perforate from end to end the parenchyma, or ſubſtance analogous to it, that gives them ſtability. And for the preſent this ſort of veſſels ſeem to me the more likely to be thoſe, that convey the blood to the extreme parts of the hair; becauſe even in horſe hairs, which yet are nouriſhed and grow, I am not yet ſure, that I have diſcovered with my microſcopes any cavity, and therefore ſuſpect there may be divers imperceptible ones, for the hair is nouriſhed and grows, which it is not like it ſhould do, if the body were ſolid; and if there were but a ſingle cavity in it, as in the lower part of a quill, it is like the microſcope I uſed would have diſcovered it, ſince with one much inferior I could eaſily ſee, that ſeveral little ſhort hairs, that grow upon the animal, that yields muſk, had each of them a cavity in it like that of the lower part of a quill.

TO the things, that have already been ſaid about the poroſity of bones, I ſhall now add an obſervation of a very learned phyſician, that is very remarkable to our preſent purpoſe, becauſe it argues, that even bodies not ſaline, nor actually moiſt, may from without get into the pores and cavities of human bones. Divers phyſicians have complained of the miſchiefs done to the bones by mercury employed to ſalivate in venereal diſeaſes: whereof I remember I have read a very notable inſtance, in a learned book (which I have not now by me) of an eminent Roman profeſſor of phyſic, who had the opportunity of making ſeveral curious obſervations in the famous hoſpital of the *incurabili* at *Rome*, and is therefore the more to be credited; where he relates, that in the cavity of at leaſt one pocky man's bones, there was found real quickſilver, that had penetrated thither. And this brings into my mind a memorable obſervation of an antient and experienced phyſician, who being famous for the cure of venereal diſeaſes, was asked by me, what inſtances he had found of the penetration of quickſilver, either outwardly or inwardly adminiſtred, into the bones of men? To this he anſwered, that he could not ſay he had himſelf taken notice of any quickſilver in the cavities of greater bones; but that ſome other practitioners had told him, that they had met with ſuch inſtances, as I inquired after. But for himſelf, he only remembered, that a patient, who had been terribly fluxed with mercurial inunctions, coming afterwards to have one of the grinders of his lower jaw pulled out, becauſe of the raging pain it had put him to; my relator had the curioſity to view narrowly this great tooth, and found, to his wonder, a little drop of true mercury in that ſlender cavity of the root, that admits the ſmall veſſels, which convey nouriſhment and ſenſe to the tooth, in more than one of whoſe three roots he affirmed to me, that he found true, though but exceeding little, quickſilver. But a full teſtimony, to my preſent purpoſe, is afforded me by the experienced phyſician *Euſtachius Rudius*, who relates, that he ſaw himſelf, and that others alſo obſerved, ſome bodies diſſected, of thoſe, that had been anointed for the venereal pox, in the cavities of whoſe bones no ſmall quantity of quickſilver was got together, which, yet, (to add that upon the by) he ſays, did not hinder ſome of them from living many years, ſurviving thoſe inunctions.

Euſtach. Rudius (apud Sennertum) lib. 5. de morbis acutis cap. 15.

CHAP. VIII.

I AM not ignorant, that among the particulars laid together in the foregoing eſſay, there are ſome, that are not abſolutely neceſſary to prove the porouſneſs of the bodies of animals. But I thought it not impertinent to mention them, becauſe I hoped, that they, in conjunction with the reſt, may be of ſome uſe to naturaliſts, in giving an account of ſeveral things, that paſs in a human body, whether ſound or ſick, eſpecially if it be of a topical diſeaſe, and may remove, or much leſſen that great prejudice, that makes many (and ſome of them otherwiſe learned) phyſicians deſpiſe the uſe of all amulets, pericarpia, and other external medicines in diſtempers of the inward parts, upon a confident, but not well grounded ſuppoſition, that theſe remedies immediately touching but the outſide of the ſkin, cannot exerciſe any conſiderable operations upon the internal parts of the body.

BUT though I have thus acknowledged ſome paſſages of the foregoing eſſay to be ſupernumerary, yet, I muſt not diſmiſs it without intimating, that I might from one topic more have fetched a probable, though not a demonſtrative argument, in favour of the porouſneſs of animals. For this may be very probably argued from hence, that even inanimate, ſolid, and ponderous bodies, that in all likelihood muſt be of a far cloſer texture, than the living bodies of animals (whoſe various functions require a greater number and diverſity of pores in their differing organs) are not devoid of pores, and have ſome of them very numerous ones, as will be ſufficiently made out in the following eſſay, to which I ſhall therefore haſten.

N. B. The following paper is that, which is referred to in the 212th page of this eſſay.

Pharmacopœiæ Regiæ claſſis xiii. *pa.* 614, 615.

Hujus rei veritatem comprobat doctiſſimus ac celeberrimus medicus & philoſophus D. Johannes Chryſoſtomus *Irmbler, ſtatuum Moraviæ marchionatûs protomedicus, his verbis ad me ſcribens: Et revera paravi ego, anno* MDCLV. *quo tempore inter infectos verſabar quotidie, trochiſcos buſonios, eóſque, ut cætera Helmontii, indefeſſi veritatis indagandæ, & ex puteò opinionum veterum noſtram credulitatem excæcantium eruendæ, nati philoſophi, experimenta ſuas laudes ſuſtinere comperi: inter viginti autem buſones vix unum quidem, jucundo ſane ſpectaculo, vidi vermiculos, per nares & oculos egreſſuros, manu repellere, quamdiu poterat, donec elanguerit buſo: ſed trochiſcos ex vermiculis unà cum pulvere emortui buſonis, & materiâ per anum (nondum vidi per vomitum;) ſcilicet alis, pedibus, capitibus, ventribus ſcarabæorum viridibus, auratiſve & nigris, quos buſo cum terra in eſcam venatur, ejectâ, cerea patinâ exceptis, cum tragacantho roſato formatos, pluribus perſonis ſuper anthraces opponi feci, atque nullum eorum mortuum eſſe dicere poſſum, ſed & meorum domeſticorum, ut & aliorum, quibus dedi, amicorum nullus, quod ſcio, infectus eſt. Sic comperi non tantùm hiſce trochiſcis enervari virus peſtilens in carbunculo jam admiſſum, ut dein vulgaribus chirurgicis remediis ulcus facili negotio fuerit curatum, ſed etiam ad ſiniſtram mammam ligatos, mihi meiſque accurſui & occurſui infectorum expoſitis, animoſitatem quandam indicibilem conferre, atque ita miaſmata & effluvia peſtilentialia abarcere. Hucuſque excel. medicus Moraviæ.*

AN ESSAY of the POROUSNESS OF SOLID BODIES.

CHAP. I.

AS it will, with far leſs difficulty be allowed, that animals and vegetables, and ſuch bodies as have belonged to either, abound with pores, than that inanimate, ſolid, and even ponderous bodies are not deſtitute of them; ſo it is far leſs difficult to make out the former, than the latter of theſe propoſitions: and therefore, *Pyrophilus*, I hope you will not expect, that I ſhould give you as many proofs of the one, as I have of the other: however I deſpair not, that thoſe I ſhall preſent you will appear ſufficient for my purpoſe, though they be not numerous enough to make me careful to marſhal them in any exact order.

OF the reaſons, that induce me to think, that even ſolid bodies are not deſtitute of pores, there are ſome, that have a greater affinity with thoſe arguments, that the ſchools are wont to call *à priori*, becauſe they require more unobvious ratiocinations upon phyſical principles; and others, which reſemble, and indeed are, ſuch proofs, as are uſually named *à poſteriori*, being ſuggeſted by the phænomena afforded us by experience, without the help of any difficult ratiocinations.

OF the firſt ſort of reaſons I ſhall propoſe to you three; and begin with that, which may be drawn from the origin and formation of divers hard bodies. For I have elſewhere endeavoured, and I hope not unſucceſsfully, to ſhew, both that divers ſtones, and even gems themſelves, and that ſeveral metalline, and other mineral bodies, were once either viſible liquors, or, at leaſt, very ſoft ſubſtances. And I have elſewhere proved, that both theſe kinds of bodies do conſiſt of, (which is the caſe of liquors) or abound in (which is the caſe of ſoft and moiſt bodies) minute particles of determinate ſizes and ſhapes: from whence, I think, one may very probably conclude, that ſuch gems and other mineral bodies, notwithſtanding any hardneſs they afterwards come to acquire, are not deſtitute of pores; ſince it is no way likely, that corpuſcles of various and very irregular figures, ſuch as thoſe of moſt liquors of the terreſtrial globe are wont to be, can be ſo brought together, eſpecially by chance, cold, or any other ſuch agents, as not to intercept little intervals or pores between them.

See the tract of the origine and virtues of gems, and the notes about the mechanical production of hardneſs.

CHAP. II.

ANOTHER thing, which makes me think the poroſity of the moſt part even of ſolid bodies to be great, is the conſideration of the great diſparity, that may be found in the ſpecific gravities of ſuch bodies, as the eye does not perceive to be porous: for, though water be a body of that kind, and though its parts be ſo cloſe packed together, that the attempts of ingenious men to make a manifeſt compreſſion of that liquor, by outward violence, have not hither proved ſucceſsful; yet we find, that ſtones, clays, metals, and even ſome woods, and a multitude of other kinds of ſolids, will readily ſink in water, and by conſequence are ſpecifically heavier than it; which greater gravity ſeems not any way explicable, without ſuppoſing, or at leaſt ſo well as by ſuppoſing, that the corpuſcles, whereof ſuch ſinking bodies conſiſt, do either lye cloſer together, or are ſeparately more ſolid, than thoſe of water; which liquor muſt conſequently be porous, though neither the eye, nor the great force, that has been ſeveral ways employed to compreſs it, can diſcover any pores in it. Upon the ſame ground I further conclude, that ſolid ſtones themſelves, as marble, flints, *&c.* are not free from poroſity: for whereas, as far as ſeveral trials, purpoſely made, can inform me, I have found, that ſuch of theſe as have nothing metalline in them, do ſeldom or never reach to treble the weight of an equal bulk of water, they will, upon the former grounds, appear to be conſiderably porous; ſince the lighteſt metals, which are tin and iron, are above twice heavier in ſpecie, that is, the bulks being equal, than marble, flints, chryſtal, *&c.* and, by the ſame reaſon, I alſo infer the great poroſity, even of the ſolid body of iron, which is as well heavier, as very much harder than tin. For though copper be a good deal more ponderous than iron or ſteel, yet I have divers times found fine gold to be more than twice as heavy in ſpecie as copper; ſince, whereas this metal, whether it be European, or brought from *Japan*, (for of that alſo I made trial) is about nine times as heavy as ſo much water; I found refined gold to be about nineteen times as heavy as water equal to it in bulk; by which it ſeems highly probable, that ſo ſolid and heavy a body, as iron or ſteel itſelf, may be ſo porous, that metalline matter, equal to it in weight, may naturally be contained in much leſs than half the dimenſions, that metal poſſeſſes. And that gold itſelf, which is the moſt compact and ſolid body we know of, is not deſtitute of pores, may appear by the diſſolution of it in quick-ſilver, of which I ſhall ſpeak a little below. And if any ſhould pretend, that hardneſs may be a greater argument of the compactneſs of a body, and its immunity from pores, than its ſpecifick weight can be; I ſhall add, that though I have found, that emery, which is the body employed to cut ſteel, and load-ſtones, and cryſtal, and the moſt of gems, being indeed much harder than marble or flints, be far heavier than thrice its bulk of water; yet that ponderouſneſs proceeds, as I elſewhere intimated, from the mixture of a metalline ſubſtance, which I have ſeparated from it. And diamonds, though much harder bodies than emery, and indeed the hardeſt we know of in nature, are ſo far from being, as ſome of late have written, the moſt ponderous of bodies, that having examined them hydroſtatically, by a way elſewhere mentioned, I found them not much heavier than either cryſtal, or fine glaſs, and not half ſo heavy as the lighteſt metals.

CHAP. III.

THE next thing, from which the porouſneſs of ſolid bodies, and even thoſe, that belong to the mineral kingdom, (as the chymiſts ſpeak) may be deduced, is the ſame with the firſt of thoſe, from which we formerly argued the poroſity of ſubſtances belonging to the animal kingdom; namely, the very frame and conſtitution of ſuch bodies: for the ſolideſt bodies themſelves reſulting from the convention or coalition of a great number of particles of ſeveral bigneſſes and ſhapes, we cannot reaſonably ſuppoſe, (eſpecially in thoſe concretes, wherein they are not ranged by a ſeminal principle) that they ſhould be contexed ſo, as to touch one another exactly every where; and therefore they muſt, of neceſſity, leave ſome little intervals and pores between them.

THIS reaſon will, I hope, appear clear enough of itſelf to him, that ſhall attentively conſider it; eſpecially if we know, that it has been geometrically demonſtrated, that there are but very few figures, that will, (as they ſpeak) *implere ſpatium*, that is, which being adjuſted to one another will ſo exactly touch, that there is not the leaſt unfilled ſpace within the circumference or circuit, if the figures be plain, or within the ambient ſuperficies, if they be ſolid; ſo that, conſidering the vaſt variety of other figures, which made *Epicurus*, and other anatomiſts, pronounce it incomprehenſible, it is very obvious to conceive, that corpuſcles of ſuch differing ſhapes being put together, will leave multitudes of little pores intercepted between thoſe parts, that do not every where touch one another. And even the mathematical figures, lately ſpoken of, may be ſaid to fill ſpace rather in a geometrical, than a phyſical ſenſe. For, if ſuch portions of matter, as are required to conſtitute, for inſtance, a cube, were actually put together, they would not exactly fill the ſpace comprehended within the ambient ſurface of the body they compoſe; becauſe the component bodies, being phyſical, conſiſt of corpuſcles of their own particular ſhapes, which we never find mathematically exquiſite. As if, for example, the cube were of marble, no art could poliſh the ſides of a component body ſo, as that they ſhould be perfectly ſmoothed; ſince (as, if I miſtake not, the learned *Gaſſendus* well obſerves) emery, pumice-ſtone, and even puttee, or other powders, that are employed to poliſh, do themſelves conſiſt of little hard angular corpuſcles, that leave ſmall ſcratches, like ſo many little furrows, on their ſurfaces, which muſt needs hinder the perfect contact of the whole ſurfaces of two contiguous bodies, and conſequently leave here and there intervals or pores between thoſe ſurfaces: to which I ſhall add, that marble itſelf, as it is marble, abounds with internal pores, as will e'er long appear by experience, and as may be rationally conjectured from the ſpecifick levity of it, in compariſon of gold and lead.

CHAP. IV.

HAVING diſpatched the arguments *à priori*, that may be employed to ſhew the porouſneſs of ſolid bodies, it will be now ſeaſonable to propoſe ſome experiments and obſervations, that may (as it were) *à poſteriori*, either evince or confirm the ſame doctrine.

OF theſe inſtances ſome relate to ſolid bodies, that are of leſs ſpecifick gravity; ſome to foſſiles, preſumed to be devoid of metalline parts; ſome to minerals, that are thought to participate of a metalline nature; ſome to metals themſelves, and ſome to glaſs.

TO begin with the firſt ſort of theſe inſtances; that wood is porous, there are many things, that argue, ſome of which are elſewhere mentioned: but few would ſuſpect, that quick-ſilver, which is ſo unapt to enter the pores of bodies much leſs compact, ſhould permeate pieces of wood of a conſiderable thickneſs; and yet, that we have made it do by the following experiment. We took a wooden trunk, ſuch as is employed to ſhoot pellets at birds with ſtrength enough to kill them, and having cloſely ſtopped one end of it, we poured in quick-ſilver at the other, till it reached to a good height in the cylindrical cavity of the inſtrument; and then the lower parts of the metalline liquor being aſſiſted by the weight of the incumbent ones, (not to mention that of the air) to preſs into the pores of the wood, they iſſued out at them on all ſides, in great numbers of minute drops, much after the manner of quick-ſilver ſtrained through leather out of amalgams; which was a phænomenon not unpleaſant to behold. But till I have opportunity to repeat this experiment with differing circumſtances, I ſhall not think it fit to lay much ſtreſs upon it, for want of knowing, what intereſt the great weight of the quick-ſilver may have had in the event.

And this caution may perchance be applicable to the following experiment; namely, that having, by the help of my pneumatical engine, withdrawn the air from one ſide of a round piece of board, the air, on the oppoſite ſide, not having its preſſure any longer reſiſted by that, which it uſed to meet with from the withdrawn air, preſſed ſo ſtrongly againſt the ſurface of the wood expoſed to it, as to make itſelf way through the pores of it, and get copiouſly enough into the cavity, whence the other air had been pumped out; (the weight of the incumbent atmoſphere doing, on this occaſion, what the weight of the quick-ſilver did on that laſt recited;) which was a ſurpriſing ſpectacle to the by-ſtanders, becauſe the board, that was thus permeated, was of ſtrong wood, and of conſiderable thickneſs.

I should here ſubjoin ſeveral other arguments of the porouſneſs of wood, if I could diſplay them without more words, than I am willing to allow them; and, I preſume, it may here ſuffice, if I let you ſee, by ſome ſurprizing effects, that when wood is reduced to that thinneſs, that its cloſeneſs or poroſity may conveniently be examined, it will eaſily enough give paſſage, even unto viſible, odorable, and tinging corpuſcles, though they invade it not in the form of a liquor, but of dry exhalations, ſo they be not incommenſurate to its pores. This, I ſuppoſe, you will not ſcruple to infer from the following trials, as they were long ſince ſet down in one of my note-books.

1. The fumes of our ſmoaking liquor [deſcribed in the foregoing eſſay] tinged a copper half-penny through a broad thin ſhaving of dale, that did not, when held againſt the window, diſcover any perforation; tinged it, I ſay, very deeply in about a quarter of a minute and ſomewhat leſs.

2. The ſame fumes tinged manifeſtly, but not ſo notably, the ſame half-penny, firſt cleanſed, through two ſuch ſhavings of dale laid one upon another, in ſomewhat leſs than one minute.

3. And, in about one minute, the ſame fumes tinged the cleanſed half-penny, through three ſuch ſhavings of dale very viſibly, but not ſo conſpicuouſly, as through the two forementioned. Theſe trials were made without the help of heat to promote the operation of the fumes.

CHAP. V.

From the conſideration of woods, let us now proceed to give ſome inſtances of the porouſneſs of bodies made of cloſe and compacted, and, perhaps, well-baked clays, or other earths.

That earthen veſſels, though ſtrong and well-baked, are many of them porous enough, may be argued not only from what has been lately recited, but from hence, that ſome of them will ſuffer themſelves to be ſoaked through by oil, others by ſolutions of nitre, and ſome other ſalts: and there are very few of them, without excepting Haſſian crucibles themſelves, that will long keep ſalt of tartar, and ſuch like fixed alcalies, in fuſion, without being penetrated by them. I have heard diſtillers complain, that when they have diſtilled corroſive materials, as vitriol and ſalt-petre, with ſtrong fires, in thoſe earthen veſſels, that are commonly made uſe of in *London*, (eſpecially by refiners) inſtead of retorts, though their necks be ſtraight and long, (upon which account they are called long-necks) a conſiderable quantity of the fineſt ſpirits make their eſcape quite thorough the veſſel; ſo that in the retort and receiver many ounces are found wanting of the firſt weight of the matter to be diſtilled; and this ſometimes, when the vitriol has been previouſly calcined, and a reaſonable allowance has been made for what may have eſcaped thorough the lute, that joined together the long neck and receiver. And though I have obſerved of our bottles, made of the ſame earth with juggs, that they are hard enough to ſtrike fire with good ſteel; yet a good experimenter upon ſuch veſſels, of whom I made inquiry, has aſſured me, that theſe, as compact as they are, may, even without external heat, have their pores pervaded by the finer parts of ſpirituous liquors.

To this purpoſe I remember, that meeting once with a virtuoſi, that was curious about the ways of making cyder as briſk and ſpirituous a liquor as he could; I inquired of him, whether he was able to keep in the ſubtile ſpirit of this ſkilfully fermented liquor in thoſe earthen bottles, that, by reaſon of the ſolidity they acquire by the vehement coction of the fire, are commonly called ſtone bottles: to which he replied, that he often found, to his trouble, that the liquor would permeate the compact ſubſtance of the bottles: and when I objected, that the ſpirits might either eſcape out at the cork, which I have made ſeveral ſpirits of divers kinds, that would readily permeate; he replied, that what he had ſaid appeared by the outſide of the bottles: to which, when I further objected, that the ſight of dew on the ſurface of the bottles would not convince me, without taſting, whether it were vinous, becauſe I had divers times obſerved, that briſk liquors would produce a dew on the outſide of the veſſels, that contained them, not by any tranſudation, (for I have made trial of it in glaſſes) but by condenſing the aqueous vapours diſperſed through the neighbouring part of the ambient air; he replied, that, beſides what his taſte had informed him of the quality of this dew, he found, that the included liquor, though exactly ſtopped, waſted in not very many months ſo conſiderably, as ſometimes to loſe a ſixth, or even a fifth part; and this eſcape, or percolation, of the liquor through the ſubſtance of the veſſels, he affirmed himſelf to have obſerved not only in one or two bottles, but in very many; and the like obſervation, for the main, was confirmed to me, upon his own experience, by an eminent phyſician, who, being a great lover of briſk cyder, uſed to bottle it up early and carefully.

Though good Haſſian crucibles be very cloſely compacted, as well as throughly baked bodies, and, upon that account, are able to keep ſilver and divers other metals long in fuſion, without letting them at all run out; yet having diſſolved ſilver in aqua fortis, I obſerved, that though the ſalts were, by this operation, ſo changed, that this horn-like ſilver did diſſolve neither in aqua fortis, nor in the aqua regia, that I put it into; yet when I kept it a while in fuſion, (which it is eaſily brought to be) among quick coals, it would, without cracking or perforating the crucible, ſoak into it, and permeate the pores of it in I know not how many places, as I convinced ſome curious perſons, by ſhewing them, on the outſide of the veſſel, a multitude of minute globules of pure ſilver, like ſo many little drops, that were got thither, as it were, by tranſudation.

CHAP. VI.

From baked earths, that are deſigned in point of hardneſs to emulate ſtones, we will proceed to give ſome inſtances of the porouſneſs of natural ſtones themſelves.

There goes a tradition, that in ſome part of the *Weſt Indies* they have a ſtone, of which they make large veſſels, wherein they put water to percolate, as it were, through a ſtrainer. Of theſe veſſels I had one ſent me for a preſent, whereof being hereafter to give ſome account in a more opportune place, I ſhall now only take notice, that I found, that water would (though ſlowly) ſoak through the veſſel, though it were conſiderably thick.

If, as many of the ancients and moſt of the modern corpuſcular philoſophers have conceived, the tranſparency and opacity of bodies proceeds from a rectitude or crookedneſs of pores, which makes them fit or unfit to tranſmit the light, that tends to pervade them in phyſically ſtraight lines: if this hypotheſis, I ſay, be allowed, we may draw a very probable argument, that ſtones may be porous, from the phaenomena of that odd gem, that is beſt known by the name of *oculus mundi*. For this ſmall ſtone (at leaſt that, which I made my obſervations of) when it is dry, and is kept in the air, is opacous, almoſt like a poliſhed piece of white amber, and ſo it continues, as long as it is kept dry; but if you put it into fair water, it will in no long time become, by degrees, quite tranſparent; and that, which I made trial of, looked then not unlike a piece of clear yellow amber, which, by degrees, does in the free air loſe its tranſparency, and turn to be opacous as before. Now, according to the above-mentioned corpuſcular hypotheſis, the pellucidneſs, which the ſtone acquires in water, may be accounted for, by ſaying, that the liquor, getting in at the crooked pores of the ſtone, does for the time rectify them, and make them pervious to the ſtraight beams of light; as we ſee, that white paper, being wetted with water, or, which does far better, being made to imbibe oil, has its pores ſo changed and rectified, that the water much leſſens its opacity, and makes it almoſt ſemidiaphanous, and the oil, if it be fine and well ſoaked up, makes it tranſparent: but upon the receſs or evaporation of the imbibed particles of water, the pores of the little ſtone, becoming crooked again, reflect the rays of light they ſhould tranſmit. Which explication will be the better allowed of, if my memory do not miſinform me, when it tells me, that a learned member of the Royal Society found the *oculus mundi* to weigh more in a nice ballance, when it was taken out of the water and well wiped, than before it was put in. This ſtone, which very few of the writers about gems take notice of, is ſo rare and difficult to be got, that I had not opportunity to make upon it all the trials I deſired; and therefore, though the ſubject be curious, I may, I hope, be excuſed, if I haſten from it to another.

There is ſo much difference in many qualities betwixt ſtones and metals, that it is very probable, that when the corpuſcles of both come to be brought together into one maſs, they will not touch one another ſo cloſe, as not to leave ſtore of little intervals or pores between them. And upon this ground I have been apt to think, that divers very hard ſtones, diaphanous and opacous, are not devoid of poroſity. For I have elſewhere delivered a way, by which I have obtained good ſtore of metalline parts, both from American granats, and from emery; though this laſt be ſo exceeding hard a ſtone, that it is uſually employed by artificers, to work upon iron and ſteel, and to cut not only rock cryſtal, but divers gems, that are harder than either that or ſteel.

Upon the ſame ground one may probably infer the poroſity of many artificial gems made by fuſion; for, to give theſe the colour of ſapphirs, topazes, amethyſts, *&c.* we are wont to add to the vitrifiable matter either ſome prepared metal, as calcined copper, calx of gold, *&c.* or elſe ſome mineral, as *Zaffora* and *Manganeze* (as the glaſs-men call *Magneſia*) that abounds in metalline parts. Nay, I remember, I have ſometimes given the colour to the vitrified ſubſtance, by employing natural gems, as granats; though to ſhew, that the coloration, which the maſs received from theſe, proceeded from the metalline corpuſcles, that lay hid in the tinging matter, the colour produced was not that, which was conſpicuous in the gem itſelf, but one very different from it, and ſuch as the metal, which, upon other accounts, I ſuppoſed the gem to partake of, ought, according to the grounds I proceeded upon, to produce in the vitrifiable matter. And this very experiment makes it alſo highly probable, that even natural tranſparent gems, (divers of which are much harder than marble, iron, and even ſteel) are themſelves porous; ſince, notwithſtanding their tranſparency, and ſeeming homogeneity, they are made up of ingredients of ſuch differing natures, as are ſtony and metalline corpuſcles.

From the ſame ground we may likewiſe deduce the poroſity of marcaſites; many of which I have obſerved to be not only hard enough plentifully to ſtrike fire, by colliſion with ſteel, but more ponderous, than even divers ores, that were rich enough in metal to be wrought with good profit: and yet theſe hard and heavy (mineral) ſtones are very far from being homogeneous; ſince I have met with few inanimate bodies, produced by nature herſelf, ſo compounded, as ſeveral marcaſites, that I have ſeen: for theſe are wont to contain more or leſs copper, and iron too; and they abound in combuſtible ſulphur, a corroſive ſalt, and a certain fixed ſubſtance, which I found to differ from true earth, but of whoſe nature the trials I have hitherto made on it have but little ſatisfied me.

I might here deduce the poroſity of the load-ſtone, as hard and ſolid a body as it is, partly from the effluvia it emits and admits, and partly from the heterogeneity I have, by chymical trials, found to be in it: but theſe things belong more properly to a paper about magnetical bodies, for which I the more willingly reſerve them, becauſe other experiments will keep them from being needful to be here inſiſted on.

The poroſity of marble and divers other ſtones of like contexture may with probability be deduced from this, that they are liable to be diſſolved by divers of the corroſive menſtruums of the chymiſts, ſuch as aqua fortis, ſpirit of ſalt, *&c.* and ſome of them even by vegetable liquors of nature's own preparing, as the juice of lemons, and that of barberries. But a more noble and ſatisfactory inſtance may be afforded, by the invention of ſtaining or colouring white marble, without employing any fretting liquor, or ſpoiling the texture of it. This way being caſually lighted on by an ingenious ſtone-cutter in *Oxford*, who gained by it both credit and money, he long ſince thought fit to acquaint me with it, upon condition of ſecreſy, (which I have to this day inviolably kept) and of my aſſiſting him to improve his invention, by making it practicable with other colours than red. Theſe circumſtances I mention, to ſignify, that I write not by gueſs of this matter, having both ſeen the experiment tried, and made it myſelf. But though I found it far leſs improvable to other uſes, than one would expect, yet, as to our preſent purpoſe, it is very appoſite: for by this way an excellent red colour may be made to ſoak into a piece of white marble, almoſt as oil will do into leather, without impairing, that I obſerved, the ſolidity of the ſtone, which, after being dyed, will be capable of a fine gloſs as before. Some other colours (yet but few fair ones) would, by this way, be brought to ſoak into marble, on which one may with them ſo define and limit the colorations, that I remember the artificer, when I brought him to kiſs the king's hand, preſented his majeſty with an andromeda, whoſe colours were ſo vivid, that this ſkilful judge of curious things, was pleaſed to honour it with a place among his rarities. And to ſatisfy his majeſty, that the fine red was not, as ſome ſuſpected, a mere varniſh, I purpoſely broke a plate of marble, in whoſe fragments he ſaw, that the pigment had ſunk to a conſiderable depth into the very ſubſtance of the ſtone; and I doubt not but it might have been made eaſily enough to ſink much deeper, if it had been thought neceſſary. A fine plate of ſuch white marble, with the penetrating pictures of coloured flowers drawn upon it, I yet keep by me to ſatisfy the curious; and ſome utenſils, as hafts of knives, ſalt-ſellers, *&c.* I have known to have laſted ſeveral years.

There is an experiment, that ſeems much ſtronger for the porouſneſs of ſolid bodies, than that itſelf (which was lately recited) of ſtaining marble: for in *Italy* ſome goldſmiths have a way of imbuing fragments of rock-cryſtal, which is a body much harder than marble, with divers colours; which do ſometimes ſo embelliſh them, that having ground off thoſe parts, that would not receive the ſame tincture, they ſet ſome of them in gold rings, and ſell them with profit. When I was informed of this, I thought of a compoſition, that I hoped might perform the ſame thing, and perhaps better than that, which was employed by them, who either knew not, or, for aught I could perceive, uſed not, ſome minerals, that I thought fit for the purpoſe. Upon this preſumption we carefully cemented ſome clear fragments of native cryſtal with a compoſition of ſome volatile minerals, together with a ſalt or two; and having ſuffered the crucibles to cool leiſurely, we had divers of the fragments ſtained here and there, ſome with one colour and ſome with another, as differing fumes happened to invade them; and of theſe colours ſome were dark or dull, and ſome vivid enough. But having conſidered the ſtained pieces, and the progreſs of the operation, more attentively, I began to doubt, whether theſe adventitious colours were really produced by the bare penetrating of the mineral fumes into the pores of the cryſtal itſelf: for I thought it poſſible, and not very unprobable, that the great heat of the fire and the ambient mixture might cleave or flaw, in many places, ſome of the cryſtalline fragments; and that the finer parts of the minerals

rals, being vehemently agitated, might inſinuate themſelves into theſe thin flaws, which, upon the ſlow refrigeration of the ſtones, ſhutting themſelves cloſe again, might lock up the tinging particles, without appearing diſcontinued, eſpecially to the eyes of perſons, that were not made uſe of with a more than ordinary attention excited by diſtruſt. This ſuſpicion was not removed by the apparent entireneſs of each little piece of cryſtal; for having taken more than once a lump of that ſtone, and ſlowly brought it to be red hot in the fire, I found, that if I warily quenched it in water, though it would thereby acquire a multitude of little cracks or flaws, which deſtroyed its former tranſparency and made it look whitiſh, yet it continued ſtill an entire body, notwithſtanding the diſadvantageous haſte, wherewith the operation had been performed. And having, after this ſuſpicion, inquired of an ingenious lapidary, that belonged to a great prince, whether, in poliſhing of gems upon a wheel, he had taken notice, that the heat would flaw them; he anſwered me, that now and then he had obſerved, that ſome ſtones, eſpecially, if I miſremember not, rubies, when they were very much heated by the ſwift motion of the engine he employed to poliſh them, did cleave, as it ſeemed to him, and gape, ſo as at firſt to make him fear the ſtones were ſpoiled; and yet afterwards they cloſed ſo perfectly, that no flaw at all could be perceived in them. I have mentioned the foregoing experiment of tinging cryſtal, to comply with the dictates of philoſophical candor, which forbids me to lay much ſtreſs upon a proof, whoſe validity I myſelf diſtruſt. But perhaps my ſuſpicion may, by further trial, which I have not now conveniency to make, appear not to have been well grounded; and in that caſe the tinging of cryſtal, as well inwardly as outwardly, by fumes, will be a noble argument for the poroſity of ſolid bodies, rock-cryſtal being harder, and probably cloſer, not only than marble, but even than glaſs.

C H A P. VII.

THAT metals, though the heavieſt of bodies, are not deſtitute of pores, may be, with probability, proved in a general way by this; that they are all diſſoluble in their appropriate menſtruums, as gold in *aqua regia*, and all the reſt in *aqua fortis*, except tin, which yet itſelf will be corroded by that menſtruum, though not well kept up in a fluid form, as it may be by another menſtruum, which I elſewhere teach: and ſometimes the ſame metal may be diſſolved by very differing menſtruums, as lead by *aqua fortis* and ſpirit of vinegar; and copper by *aqua fortis*, *aqua regia*, ſpirit of vinegar, ſpirit of ſalt, and ſome other ſolvents, that, upon trial, I have found ſufficient for that purpoſe.

BUT it will, I preſume, be thought more conſiderable to my preſent argument, if it be ſhewn, that bodies, that appear groſs, and which in their natural ſtate are not fluid, and are confeſſed to be of a compounded nature, will penetrate metals quite through, even without melting them.

THIS we have divers times effected, by a cementation of copper plates with common 🜍 (much a kin to a way preſcribed by ſome alchymiſts to make *vitriolum Veneris*) which we warily performed much after this manner. We took good copper, laminated to the thickneſs of a ſhilling or thereabouts, and having cut it into ſmall pieces, that they might the more eaſily be put into a crucible or cementing pot, we ſtrewed at the bottom of the veſſel ſome beaten 🜍, and then covered it pretty well with ſome of theſe plates, which were laid on flat-wiſe. Upon theſe we ſtrewed another bed of powdered brimſtone, and covered that alſo with plates, upon which we put more ſulphur; and ſo continued making one lair of brimſtone, and another of metal, till we had employed all our plates, or filled the crucible, being careful, that the uppermoſt bed, as well as the loweſt, ſhould be of ſulphur. This done, we luted on an earthen cover to the veſſel, to keep the 🜍 from taking fire; and afterwards having placed the pot amongſt coals kindled at a good diſtance from it, that it might be heated by degrees, we kept it for ſome few hours (perhaps two or three) in ſuch a degree of fire, as was ſufficient to keep the ſulphur melted (which is eaſily enough done) without bringing the metal to fuſion; the pot being cold, we took off the cover, and found the plates quite altered in colour and texture, ſome of them having a dark and dirty colour, whilſt others looked of a fine violet or blue: they were generally ſo brittle, that it was very eaſy to break them with ones finger, and reduce them to powder. And (now to add ſuch circumſtances as a chymiſt would not take notice of) many of the plates, when they were broken, appeared to have been (by the contiguous beds of ſulphur above and below) horizontally divided each of them into two plates, divers of which in ſome places had a manifeſt diſtance or cavity between them: and it was obſervable, that when I conſidered one or other of theſe plates attentively in the parts, that had been contiguous before I broke it, I could plainly diſcern a multitude, as it were, of fibres, reaching from one of the flat ſides of the plate to the other, and running many of them, as to ſenſe, parallel to one another. Theſe circumſtances may ſufficiently argue, that the plates were pierced quite through by the brimſtone; but for confirmation of this, and to ſhew too, that the ſulphur does, as it were, ſoak into the body of the metal, and in a groſs manner lodge itſelf there; I ſhall add, that not only to the eye the plates appeared much ſwelled, or thicker than when they were put in, but having weighed them before the operation was begun, and after it was quite ended, the copper, though it needed not to be freed from externally adhering ſulphur, was found to have a conſiderable increaſe of weight by the acceſſion of the ſulphur, which (to add that circumſtance) though it appeared not to the eye, yet if a plate were laid upon quick coals, and blown, would oftentimes diſcover itſelf by a blue flame.

By making the like experiment for the main, we found, that refined ſilver, though a more heavy and compact body than copper, and not diſſoluble by moſt of the menſtruums, that work on this metal, is penetrable by the body of ſulphur, which will alſo calcine tin and lead, and (eſpecially) iron.

Nor is ſulphur the only conſiſtent body, that has this ingreſs into metals; for we have found them penetrable by prepared arſenick. But becauſe theſe operations are not ſo eaſy, and the ſubject is not eaſily handled without danger, I forbear the mention of them in this place, where, after what has been recited, it is not neceſſary.

Another experiment there is, which does more advantageouſly, than that made with brimſtone, diſcover the poroſity of copper. For there is a way, by which, without the help of ſalts, ſulphur or arſenick, one may make a ſolid and heavy body ſoak into the pores of that metal, and give it a durable colour. I ſhall not mention the way, becauſe of the bad uſe, that may be made of it. But having had the curioſity more than once to try it upon a new copper farthing, the event was, that one part of it, which I purpoſely forbore to tinge, remained common copper ſtill; but the other part acquired a yellow, that differed very little, if at all, from a golden colour, the former ſtamp, that was impreſſed upon the coin, continuing viſible. And to convince the ſcrupulous, that the pigment did really ſink, and, as it were, ſoak into the body of the metal, and did not meerly colour the ſuperficies, I made them take notice, that the farthing was not melted, and yet, by filing off a wide gap from the edge of the coin inwards, it plainly appeared, that the yellow or golden colour had penetrated a pretty way beneath the ſurface of the farthing; ſo that it looked there, as if two thin plates, the one yellow, and the other reddiſh, did, without any interval between them, lie upon one another.

If bodies be not to be pervaded, or deeply pierced into, by corpuſcles, but only to have their more ſuperficial pores, if I may ſo call them, penetrated thereby, it is poſſible, that bodies, which are either much harder, or much cloſer, than marble, alabaſter, or the like bodies, may have their pores poſſeſſed even by odorous corpuſcles; I ſay, even by ſuch, becauſe they are moſt of them groſs enough to be kept from exhaling by bodies much leſs compact than earthen bottles, and are far from being of the fineſt particles, that nature affords. But that ſuch odorous corpuſcles may lodge themſelves in the exterior pores of very cloſe bodies, I have been inclined to think, not only by the obſtinately adhering odour, which I found, by trial, that ſome ſubtile and ſpirituous parts, ſuch as the chymiſts would perhaps call, in their aggregates, the eſſence of muſk, amber, ambergreece, *&c.* notwithſtanding the waſhing of the glaſſes, that had long contained ſuch liquors; but by what has been aſſured me by a phyſician of great experience, who travelled and lived much in the eaſt. For having told him, that I had been informed, that in ſome places, leſs famous than *Damaſcus* for curioſity in making fine ſword-blades, there was a way found and practiſed of making them richly ſcented, without injury to their gloſs, I deſired to know of him, if at *Damaſcus*, or elſewhere, he had ſeen any of them; to which he replied, that he did not remember he had, but yet made no doubt the information might be true; for he himſelf had in *Europe*, and kept for divers years, a watch, whoſe metalline caſe was richly perfumed: and when I aſked him, whether there were not ſome thin varniſh, or ſome outward caſe of perfumed leather, or chagreen, or ſomewhat elſe, from whence the odour proceeded; he aſſured me, that his obſervations had prevented and removed that and divers other ſcruples, and that the caſe being clean and gloſſy, he could not perceive, that the odour proceeded from any thing elſe than ſome odoriferous thing or other, that was inviſibly lodged in the pores, or porous ſubſtance of the metal itſelf. And indeed, ſince both arſenick, and even common ſulphur, may by art be, as it were, incorporated with ſome metals, and even with ſilver, I ſee not why it ſhould be impoſſible, that ſome pleaſingly ſcented ſubſtances ſhould be admitted into the pores of metalline bodies, and be volatile enough to have their ſubtiler parts fly off in odorous exhalations, eſpecially if they be a little excited, as the watch-caſe lately mentioned was, by a gentle heat, ſuch as was that of the wearer's pocket. And on this occaſion I remember to have made a certain metalline compoſition, which looked like gold, and of which I cauſed a ring to be caſt; and yet this metal retained ſo many unperceived mercurial corpuſcles in it, that an ingenious perſon, to whom I diſcovered the compoſition of it, found, after trial, as he aſſured me, that being worn as a ring, it had in ſome diſtempers, particularly of the eyes, manifeſt operations, that evidently enough ſeemed to flow, at leaſt in great part, from its participation of the mercury we employed in preparing the factitious metal.

Since the writing of the former part of this eſſay, having met with an inquiſitive nobleman, who had lived in ſeveral parts of *Africk*, and was governor of the beſt town the *Europeans* have on that continent, I diſcourſed with him, among other things, about the ſkill, that ſome aſcribe to the African Moors, of making excellent weapons, whereof I knew his excellency was very curious. Upon which occaſion he told me, that ſome of the off-ſpring of the Granadine Moors were indeed the beſt at making arms, that ever he met with; and that he had ſeen ſome weapons of their forging and tempering, that he preferred even to thoſe of *Damaſco*. And when I aſked him, whether any of them had the art of perfuming their weapons? he anſwered me, that ſome of them did it admirably well, and inſtanced in a blade, which he kept for ſome years, and found it ſtill to retain the perfumed ſcent, which he ſuppoſed to be, as it were, incorporated with the ſteel, whereof the blade was made. When I told him I ſuſpected, that the ſcabbard might have been well perfumed, and communicate its odour to the contained blade, he allowed the objection to be plauſible, but replied, that it was not concluding, ſince miſliking the ſcabbard, as not handſome and faſhionable enough, he cauſed a new one to be made, wherein he afterwards kept it. And the ſame lord further told me, that he had alſo a fowling-piece, whoſe barrel was perfumed. And when I objected, that perhaps the odoriferous ſcent proceeded from the ſtock, and not from the metal; he anſwered, that the gun not being, when it came into his poſſeſſion, ſkilfully and handſomely mounted, he cauſed the barrel to be fitted with a new ſtock, notwithſtanding which, it continued to ſmell fragrantly. And when I further aſked, whether he ever cauſed the gun to be waſhed or ſcoured after it was grown foul by having been often ſhot in? he anſwered me, that he had, and, as far as I can remember, ſubjoined, that after it was made clean, it did (notwithſtanding the ill ſcent, that the ſoot of the powder had given it) retain a pleaſing ſmell, but fainter than before.

CHAP. VIII.

SINCE the ſubject of this eſſay is the porouſneſs of ſolid bodies, and ſince there is no body, that is generally reputed ſo cloſe and compact as glaſs, it will be pertinent to this diſcourſe, and probably will be expected, that I ſhould here ſay ſomething about the queſtion, whether glaſs be, or be not, devoid of pores.

BUT before I acquaint you with my trials, or my thoughts, about this problem, I think it requiſite to clear the ſenſe, in which I mean to handle it, that I may not, as ſome others have done, for want of diſtinctly ſtating the queſtion, ſpeak confuſedly and erroneouſly of it.

I SHALL then here obſerve, to prevent miſtakes, that the poroſity of glaſs may admit of two acceptions: for it may be ſaid to be quite pervious to fluids, as a boot is to water, or only to be capable of having its ſuperficial parts further and further diſſolved or corroded thereby, as a ſilver cup is porous in reference to *aqua fortis*, which cannot ſweat through it, as water does through a boot, but eat its way through it, by diſſolving the texture of the veſſel.

ANOTHER thing requiſite to be premiſed, to prevent ambiguity, is, that glaſs itſelf is not all of one ſort, as men unacquainted with chymiſtry are wont to preſume; for glaſs of antimony, for inſtance, and that of lead, both of them made *per ſe*, do manifeſtly differ, uſually in colour, and conſtantly in weight, and alſo in their operations upon human bodies; and both theſe ſorts of glaſs do in ſeveral points differ from common glaſs, under which name, for brevity's ſake, I comprehend both white or cryſtalline glaſs, as it is called in the ſhops, and that courſer ſort, which they uſually call green glaſs; both which ſorts I here conſider under one notion, becauſe both are made of fixt alcalies, and other fit ingredients, as ſand, earth, aſhes, pebbles, or flints, colliquated by a ſtrong and laſting operation of the fire: and it is of this common glaſs, in the ſenſe now declared, that I ſhall conſider the poroſity in the remaining part of this eſſay; in which, to proceed with ſome method, I ſhall digeſt what I have to ſay, into the enſuing propoſitions, and the obſervations annext to them.

Prop. I. *It is very probable, that glaſs may be pierced into to ſome diſtance, even by viſible and tangible bodies.*

I KNOW, that this will ſeem a paradox to many, and repugnant to common experience, which ſhews, that glaſs veſſels will contain very ſubtile and even highly corroſive liquors, as the ſpirit of hartſhorn, of urine, and that of nitre; as alſo thoſe potent menſtruums, as *aqua fortis*, *aqua regis*, and oil of vitriol, which not only are not obſerved to pierce into it, but are unable to make any ſenſible alteration, ſo much as on the ſuperficial parts, even in thoſe vials, wherein they have been long kept.

BUT, notwithſtanding all this, I preſume you will not condemn the lately propoſed paradox, when you have conſidered what may be ſaid to juſtify it. For beſides that it may be made probable *à priori*, by the arguments, whence we have formerly proved the porouſneſs of ſolid bodies in general; there are two ſorts of experiments, from whence one may argue, that glaſs, in particular, is not devoid of pores in the ſenſe, wherein we are now ſpeaking of them.

AND firſt, I remember, that having kept for a good while in a vial a quantity of a certain ſpirit of ſalt, that I had reſerved in a cool place, I found, when I came to uſe it, that the glaſs was crackt, and moſt of the liquor was run out; but, before this happened, it had ſo far corroded the inſide of the glaſs, that in ſome places it was eaten almoſt as thin as a piece of paper; and this part, which yet continued glaſs, was lined with a much thicker white ſubſtance, that ſtuck to the ſides of it, and looked and taſted like a kind of odd ſalt: ſo that it invited me to conjecture, that it proceeded from the ſubſtance of the glaſs, which, you know, conſiſts of an alcali, as well as of ſand, corroded by the ſaline ſpirits of the menſtruum, and coagulated with them into this odd kind of concrete; and it was remarkable in our veſſel, that the upper part of the vial, to which the menſtruum did not reach, was not corroded nor altered, though the operation of the liquor reached as high as the liquor itſelf. And I remember, that when I related all this to ſome experienced chymiſts, one of them, that was a more heedful obſerver, aſſured me the like had once or twice happened to him, as ſince that time it hath likewiſe done to me.

I HAD alſo, if I miſremember not, another vial, corroded by a diſtilled liquor of vitriol, that had in it more of the phlegm than of the oil; which you will ſomewhat the leſs wonder at, if you conſider, that ſome corroſive menſtruums will ſcarce work on ſome bodies, if they be too well dephlegmed, or at leaſt will not corrode them ſo readily and powerfully, if they are very ſtrong, as when they are diluted with a convenient quantity of water. And, as to oil of vitriol itſelf, which is the menſtruum I am ſpeaking of, when we employ it to make *vitriolum Martis*, we are wont to weaken it with water, that it may the better diſſolve that metal. And, perhaps, you will ſuſpect, that vitriol has ſome peculiar faculty of penetrating and fretting glaſs, when to the experiment newly recited I ſhall add that, which follows, as I find it regiſtred among my notes.

[A pound of Dantzick vitriol and a pound of ſea-ſalt, after the former had been very lightly calcined, and the latter decrepitated, that they might not boil in, or crack the veſſel, we cauſed to be diſtilled in a well coated retort by degrees of fire, giving at length a very ſtrong one; then taking off the veſſel, we were not much ſurprized to find, that the heat had here and there melted it, and that the fluxed *caput mortuum* had corroded the glaſs, fetching off, as it were, films from it; and thoſe parts, which did not appear to the eye thus manifeſtly waſted, ſeemed yet, by their great brittleneſs, to have been penetrated, ſo that their texture was ſpoiled by the ſaline and vitriolate corpuſcles.]

PROP. 2. *Common glaſs is not ordinarily permeable by chymical liquors, though ſtrong and ſubtile, nor by the directly viſible or odorable expirations of bodies, though, abſolutely ſpeaking, it be pervious to ſome corporeal ſubſtances.*

THIS propoſition conſiſting of two parts, we ſhall allow each of them its diſtinct proofs.

AND as for the firſt part, it is manifeſtly agreeable to the common experience of chymiſts, who daily find, that in well ſtopt vials, or at leaſt in hermetically ſealed glaſſes, they can preſerve their ſubtileſt and moſt piercing menſtruums, as ſpirit of nitre, *aqua fortis*, ſpirit of ſalt, ſpirit of vinegar, and oil of vitriol. And, this they found to be true, not only as to acid and corroſive liquors, like thoſe I have newly named, but alſo in thoſe ſpirits, that abound with fugitive ſalts, as the ſpirit of urine, of blood, and of ſal-armoniac; and in the moſt ſubtile and highly rectified ſpirit of wine; as alſo in the ethereal oil, or, as many call it, ſpirit, of turpentine; as likewiſe in the liquors of ſalt of tartar, and other fixt alcalies reſolved by deliquium.

THE reſult of theſe obſervations may be much confirmed by conſidering, how often it happens in the diſtillation of more wild and fugitive ſpirits, as of nitre, tartar, and ſugar, that, though they are much agitated, and perhaps ſubtilized, by heat, yet if the lute, that joins the receiver to the retort, be very firm and cloſe, the receivers, though large, are often broken in pieces; which probably would not happen, if the ſpirits could inſinuate and croud themſelves through the pores of glaſs.

BUT, whereas it may be pretended, that ſuch veſſels are ſtrong and thick, I ſhall add, that I have had the curioſity to cauſe very fine bubbles to be blown at the flame of a lamp, purpoſely that they may be made extremely thin, and of but a ſmall part of the thickneſs we meet with in the veſſels made at the glaſs-houſe; and ſome of theſe I cauſed to be exactly ſtopt, and others to be hermetically ſealed; but could not find, that either dry ſalt of tartar would relent in one, that was kept a good while under water, or that ſtrong ſpirit of ſal armoniac, which is one of the ſubtileſt ſpirits, that we know, would penetrate one of theſe thin films of glaſs, which we kept a great while immerſed in it, though to diſcover, whether it would at all penetrate the thinneſt glaſſes, we employed ſome, which were of that fine ſort, that is called eſſence vials.

THESE and ſome other trials have, I confeſs, made me very diffident of the experiments, that have been delivered by ſome men of note, and built upon by others, of the permeableneſs of ordinary glaſs veſſels to chymical liquors; as, that mercury and *aqua fortis*, being digeſted together in a bolt-head, may, by rubbing the outſide of the glaſs, be made viſibly and palpably to tranſudate: which experiment (if my memory do not much deceive me,) I purpoſely tried with care, but without ſucceſs.

BUT, after all this, I muſt deſire, that it may be remembred, that in wording the propoſition of the imperviouſneſs of glaſs, I intimated, that I would have it underſtood of what ordinarily happens; for in ſome extraordinary caſes, which I take to be exceeding rare, I do not abſolutely deny, but that the general rule may admit of exceptions. And, if it be lawful to conjecture, theſe exceptions are likelieſt to take place, when the peculiar texture of this or that glaſs is more ſlight or lax than ordinary; or, when the bodies, that are to pervade it, are vehemently agitated by heat; or when, beſides a great ſubtlety, and perhaps degree of heat too, their particles chance to have a ſpecial congruity to the relaxed pores of that particular glaſs they are to paſs through. I remember I have ſeen, not without ſome wonder, a ſort of glaſs of ſo ſoft and reſoluble a texture, that veſſels of it of a competent thickneſs would be manifeſtly prejudiced and wrought upon by liquors, that were not conſiderably ſharp or corroſive, if they were put in very hot. I have alſo heard of another ſort of glaſſes, made in a certain foreſt, complained of by a diſtiller, as ſubject to be ſometimes injured by corroſive liquors. I once knew a doctor of phyſic, that by divers credulous alchymiſts was ſuſpected to have, what they call the philoſopher's ſtone, becauſe of a certain book, ingenious enough, that he was ſuppoſed to have written on that ſubject. But when, after ſome acquaintance, I happened to debate his principles freely with him, he confeſſed to me, that he had been miſtaken; and to invite me to give him my thoughts upon ſuch like works, he frankly made me an ingenious relation of his proceedings, wherein the main thing, that dazzled him, and kept him from ſeeing his error, was, that he had reduced the matter he wrought on, which was real gold, to that degree of fuſibleneſs and ſubtlety, that when he gave too ſtrong a fire, as miſtake or curioſity made him ſeveral times do, the finer part of the metal would ſweat through his glaſſes, and ſtick ſometimes to the outſide of them, and ſometimes to the neighbouring bodies. And when I objected, that he might be miſtaken in this, and that what he thought had come forth by tranſudation, rather iſſued out at ſome ſmall unheeded crack; he replied, that he had made the obſervation ſo often, and with ſuch care, that he was fully ſatisfied it was a real penetration of the glaſs by the attenuated metal, which he was to have convinced me of by trial. But, before he could come to make it, by an error of his own he unhappily died.

BUT, whatever be judged of this penetrating gold, I elſewhere relate, that I having upon a time diſtilled ſpirit of hartſhorn with a very ſtrong fire, into a receiver, that was large and thick enough, but of a courſe kind of glaſs, it did appear, upon my beſt examination, that the glaſs itſelf was penetrated by ſome vehemently agitated fumes, or ſome ſubtile liquor, that ſettled in ſtrongly ſcented drops on the outſide of the receiver. But ſuch inſtances being very rare, and happening but in ſome caſes or conjunctures of circumſtances, that are not like to be at all frequent, they cannot hinder the firſt part of our propoſition to be true in the ſenſe, wherein it is laid down.

AND as to the ſecond part of the propoſition, which *aſſerts glaſs to be pervious to ſome corporeal ſubſtances*, it may be proved *ad hominem* againſt any Epicurean, that ſhould deny it, (and the Carteſians muſt not) by the free ingreſs and egreſs, which our ſealed thermoſcopes ſhew, that the atoms or corpuſcles of cold and heat are allowed, through the pores of the glaſs, that contains the riſing or falling tincture, or other liquor. And without proceeding upon the peculiar principles of the Epicureans, we may give more certain proofs of the permeableneſs of glaſs by certain bodies: for I have elſewhere manifeſtly evinced, that the effluvia of a loadſtone will attract and invigorate ſteel, though incloſed in hermetically ſealed glaſſes; nay, I have alſo ſhewn by experiment, that the effluvia of ſo groſs and dull a body as the earth are readily tranſmitted through glaſs, and will operate on iron, in veſſels hermetically ſealed. If light be, as probably it is, either a ſubtile and rapidly moving body, or at leaſt require ſuch an one for its vehicle, it muſt not be denied, that it is poſſible for a body without difficulty to paſs through the pores of glaſs; ſince it is by its help, that we can clearly ſee the dimenſions, ſhapes, and colours of bodies included in glaſſes. To this I ſhall add, that far leſs ſubtile bodies, than thoſe, that conſtitute or convey light, may be made to permeate glaſs, if their figures being congruous enough to the pores of it, their penetration be aſſiſted by an impetuous motion, or a briſk impulſe; as I have found by the increaſe of weight in ſome metals expoſed for divers hours in hermetically ſealed glaſſes to the action of a flame: on which occaſion I remember, that having ſome years ago tried the ſame experiment with ſome filings of copper, they had indeed their colour much altered, being beautified with exceeding vivid dyes, which they yet retain, but did not evidently appear to be increaſed in weight, as if, becauſe they were not of a texture looſe enough to be melted, the igneous particles could not pierce them enough to ſtick faſt in them, at leaſt in numbers great enough to amount to a ſenſible weight.

BUT without the help of fire, or any ſenſible heat, I think it not impoſſible, that glaſs ſhould be freely penetrated by ſome kind of corpuſcles, (though I do not yet know of what ſort they are) that ſometimes happen to rove about in the air. This you will probably be ſurprized to read, but, perhaps, no more than I was at the phænomena, that induce me to write it. But becauſe theſe are very unuſual, and can ſcarce be diſcourſed of without ſome odd reflections hinted by them, I thought fit to ſet down a circumſtantial account of them in another paper, to which it more directly belongs, than to this eſſay; and therefore ſhall now only tell you, what may be ſufficient for my preſent purpoſe: namely, that having in two or three vials cloſely ſtopt, kept a certain limpid and colourleſs liquor, it would by fits acquire and loſe a high colour, though I could not reaſonably impute the changes to any manifeſt ones in the air, nor to any other cauſe ſo probable, as the ingreſs and receſs of ſome very ſubtile and uncommon particles, which at that time happened to ſwim to and fro in the air, and now and then to invade, and ſometimes to deſert, the liquor.

There is another ſort of experiments relating to the poroſity of glaſs, to ſhew, that it may be pierced into by bodies, that are not corroſive in taſte, and are not liquors; but only have a forced and temporary fluidity, if they have ſo much as that.

These experiments may be drawn from ſome of the ways of colouring panes of glaſs for the windows of churches and other buildings; I ſay ſome of the ways, becauſe, to deal candidly with you, I think, and ſo I preſume will you e'er long, that in divers of thoſe glaſſes the colour doth not pierce at all deep into the glaſs, but is produced by the cloſe adheſion of a deep red, but thin and tranſparent pigment to the ſurface of a glaſſy plate, through both which the beams of light paſſing to the eye, receive in their paſſage the colour of the pigment.

But as, by ſome operations, the glaſs is rather painted, or externally enamelled, than tinged, ſo in ſome others the pigment or dying ſtuff appears to pierce a little beneath the very ſuperficies of the glaſs, and the yellow colour will not only go further or deeper, but ſometimes ſeems (for I do not yet poſitively affirm it) to penetrate the whole glaſs from ſide to ſide.

The methods of painting and ſtaining glaſs having been hitherto the practices of a particular trade, that is gainful enough and known but to few, the artificers are wont to be ſhy of communicating their ſecrets; though we know in general, that glaſs is ſtained, by having the plates covered with mineral pigments, laid on beds of beaten lime, or ſome other convenient powder, and kept for divers hours in a ſtrong fire, but yet not ſtrong enough to make the plates melt down; by which means the pores of the glaſs being much opened by the heat, and the pigments being likewiſe agitated, and ſome of them, as it were, vitrified with it, they are made either to pierce into the plate, or at leaſt to ſtick very cloſely and firmly to it. But, becauſe the practices of glaſs painters require, beſides ſkill and experience, a particular furnace and divers implements, I ſhall add, that to try, whether glaſs may not, without ſo much ado, be ſo ſtained, as to ſhew it to be porous, we took prepared ſilver, (that metal having, of all the minerals I have tried, the beſt ingreſs into glaſs) and having laid it upon a piece of glaſs, not thick, nor yet ſo thin as to melt very eaſily, we laid this glaſs (with the pigment uppermoſt) warily upon a few quick-coals; and having ſuffered it to neal a while, we gave it about ſuch a degree of heat, as might make and keep it red-hot, without bringing it to compleat fuſion; and then, ſuffering it to cool by degrees, we found, as we expected, that the glaſs had acquired a yellow, and almoſt golden, colour, which was not to be waſhed off, or to be taken away, without ſuch ſcraping as would injure or ſpoil the glaſs itſelf. The way of preparing ſilver for this operation, is not always the ſame: the glaſs painters commonly add to the calcined ſilver ſome mineral bodies, as antimony, yellow oker, or the like. But I, who take the penetration of the colour to proceed from the ſilver itſelf, do ſometimes employ only ſome thin piece of ſilver, ſuch as an old groat, upon which a little ſulphur being put, and kindled in the open air, the metal is preſently calcined, and the powder made uſe of. And this itſelf I do not ſo much out of neceſſity, as becauſe the calcination reduces the metal into ſmall parts, and gives it a form, that makes it more eaſy to be laid on, as one thinks fit. For, otherwiſe, going upon this my ſuppoſition, that the ſilver was the true pigment of the glaſs, I have more than once made glaſs yellow by leaf-ſilver laid flat on the ſurface of it, and a little moiſtened, to keep ſo light a body from being blown off. And (to note that upon the by) it is pretty, that if the fire be made too ſtrong, which it is hard to avoid doing, when we will make it ſtrong enough without the help of a furnace, it has ſeveral times happened to me, that the died glaſs, though when held againſt the light it appeared of a golden or yellow colour, yet when held from the light it appeared blue; ſo that here we have in a mineral ſomewhat, that is very like that we admire in the tincture of *lignum nephriticum*, which ſhews almoſt the like difference of colour, as it is held againſt or from the light; which may ſerve for a confirmation of what I have elſewhere ſaid, to ſhew, that colours may be derived from mechanical principles: but that only upon the by. Whether the gold colour produced by ſilver do favour the hopes of thoſe alchymiſts, that work on that metal, upon preſumption that it is but unripe gold, it is improper here to examine. But ſince yellow is not the colour of ſilver, it ſeems the yellowneſs acquired by our glaſs plates argues, that there has been ſome ingreſs of the ſubſtance of the particles of the ſilver into the glaſs, there appearing no way ſo ready to give an account of the change of colours, as by ſuppoſing the particles of the ſilver to be wrought on by the fixt ſalts, and other fine parts, of the glaſs; ſince we know, that metals may afford differing colours, according to the ſaline and other bodies, that work upon them, as copper with ſpirit of urine, which abounds in volatile ſalt, gives a deep blue; with ſpirit of ſalt, a fair green; and with *aqua fortis*, a colour, that participates of both. And in the making of glaſs of lead with minium and white-ſand, or cryſtal, the glaſs itſelf, if well made, is uſually of an amethyſtine colour; but, if you put a due proportion, (which is a very ſmall one,) of calcined copper to it, this metal will not communicate to the glaſs its own reddiſhneſs, but be ſo changed by it, as to give it a good green, and ſometimes ſo good an one, that pieces of this glaſs, ſuch as we have cut and cauſed to be ſet in rings, might, among thoſe, that judge of ſtones but by the eye, paſs for no bad emeralds.

On this occaſion it is likely it will be aſked, whether there be any way of tinging glaſſes quite through, with a true and beautiful red, and whether the art of dying plates of glaſs, which the windows of many old churches ſhew to have formerly been practiſed, be now (as it is commonly ſuppoſed) altogether loſt?

This queſtion, conſiſting of two parts, I ſhall quickly diſpatch: the former, by anſwering it without heſitancy in the affirmative; yet, adding withal, that the red tincture being communicated to glaſs, not properly by mere penetration of the pigment, but by the incorporation of it with glaſs or its materials, by the help of fuſion, I think the experiment of no ſuch great uſe in our preſent inquiry, as to hinder me from reſerving what I have obſerved about it to a more opportune place. And as to the ſecond part of the inquiry, it being rather a hiſtorical, than a philoſophical queſtion, I ſhall not here meddle with it; only I ſhall wiſh the queſtion may be cautiouſly ſtated. For, upon the burning the famous cathedral of St. *Paul's* church in *London*, many pieces of the red glaſs, that adorned the windows, were found broken and ſcattered about, ſome of which I procured from a chymiſt, that had carefully preſerved them, deſigning to retrieve the loſt invention of making the like: but when I came to examine them narrowly, I was confirmed in the ſuſpicion I had, that the redneſs did not penetrate the whole glaſs, but proceeded from a diaphanous pigment very artificially laid on; for though in other poſtures no ſuch thing could be diſcerned, yet, when I ſo held it, according to my cuſtom in examining painted glaſſes, that the ſurfaces of the plate lay in the ſame level with my eye between it and the window, ſo that a broken edge was next my eye, I could plainly ſee, and made the chymiſt himſelf ſee, the lower part of the plate to be of ordinary uncoloured glaſs, upon which there lay a very thin plate or bed of a diaphanous red pigment, which, though it were not eaſily, was not impoſſible to be here and there ſcraped off.

But to return to thoſe colorations, that ſeem to pierce into the pores of glaſs, I remember, that I had once occaſion to diſtill in a ſmall retort ſome gold amalgamed with ſuch a fine and ſubtile mercury, that being (without the addition of any ſalt) put to the gold in the cold, they preſently grew hot together. And in the diſtillation of this uncommon mixture, I found the matter had, before it flew away, permanently dyed or ſtained, about an inch in diameter of the bottom of the glaſs, with a colour, that, looked on from the light, was like that of the better ſort of turquoiſes; but beheld, when it was interpoſed between the window and the eye, appeared of a ſomewhat golden colour. And this glaſs, with ſome others oddly coloured, I have yet by me to ſatiſfy the curious, though I cannot but give advertiſement, that the colorations of glaſs may be much better performed with ſuch plates, and in ſuch furnaces, as the glaſs-painters uſe, than without them.

Since the writing of the foregoing paragraph, I was viſited by an induſtrious perſon, much addicted to ſome chymical operations, who had formerly adviſed with me about a proceſs, of which I had had ſome expeence, that he conceived might be uſeful to him. I then acquainted him with ſome of my thoughts about it, and he having afterwards united gold with quickſilver, (which, by its effects, will be eaſily concluded not to have been in common) he kept them in digeſtion for ſome months; and afterwards coming to me with a melancholy look, told me, that the fire having been once immoderately increaſed in his abſence, the ſealed glaſs burſt with an affrighting noiſe, and the included amalgam was ſo ſtrangely diſſipated, that ſcarce the leaſt fragment of it could be retrieved. But the decoction having continued ſo long a time, it ſeems the matter was ſubtiliated enough to have a notable operation upon the glaſs: for, though the upper part of the bolt-glaſs were blown off, and ſhattered into many pieces, yet the lower part eſcaped well enough; and when he brought it me to obſerve, what change had been made in it, I took notice with much delight, that the glaſs ſeemed to be tinged throughout with ſo fine and glorious a red colour, that I have ſeen ſeveral rubies themſelves, in that point, inferior to it.

SHORT
MEMOIRS
FOR THE
NATURAL EXPERIMENTAL
HISTORY
OF
MINERAL WATERS.
ADDRESSED
By way of LETTER to a FRIEND.

ADVERTISEMENT of the PUBLISHER.

I Find by ſome diſcourſe I lately had with the author, that his deſign, in drawing up his memoirs, being to ſet down what had occurred to him of his own obſervation and experiments, he purpoſely forbore to conſult the authors, that have profeſſedly written upon medical waters: he would by no means have it thought, that he undervalued thoſe learned writers, that he forbore to cite, becauſe he had them not at hand, as well as becauſe his deſign did not require he ſhould tranſcribe from them. And therefore he deſires, that his readers ſhould not be kept, by any thing he has written, from conſulting other writers, that have treated of mineral waters, eſpecially the late ingenious exercitations of the learned Dr. *Liſter de Fontibus medicatis Angliæ* (after mentioned by our author,) and the curious little tract of the *French* mineral waters, that was brought our author in *Engliſh*, after his memoirs were come to him from the preſs, publiſhed by the virtuoſi of the famous Royal Academy of Sciences at *Paris*, eſpecially where they curiouſly examine the ſaline and earthly reſidences of waters, which our author has not done to the remains of our *Engliſh Acidulæ*, of which liquors he had for the moſt part ſuch incompetent quantities, as concurred with another reaſon to diſcouraged him from publiſhing his trials on them. Yet, I may ſafely ſay, what he offers here to the reader is far beyond any thing, that has been publiſhed in this kind; for the virtuoſi, as well as the water-drinkers, may reap no ſmall benefit by the peruſal of this learned treatiſe, as containing a great number both of uſeful obſervations and unuſual experiments.

ADVERTISEMENT.

THE author of the following papers had thoughts of reviewing and enlarging them before he parted with them; and, at leaſt, of annexing notes to ſeveral of thoſe titles of the hiſtorical platform, that are yet left untouched. But, beſides his want of health and leiſure, he was, by the ſupervening of ſome urgent occaſions, obliged abruptly enough to lay aſide this work he was about, and apply himſelf to others, that concerned him more, than the ſcrutiny of mineral waters could. Wherefore conſidering, that he had already made annotations, though but ſhort ones, upon moſt of the conſiderableſt titles or topicks of inquiry enumerated in the ſecond and principal part of his ſchemes above them, he was content to give the enſuing writing, unfiniſhed as it was, to the ſollicitations of ſome virtuoſi, who rather than tarry, till he ſhould have an opportunity, which he knows not how long he ſhall want, were deſirous to take what they found ready, with all its imperfections. Which preſſingneſs of theirs he could not deny to be the more excuſable on this occaſion, becauſe the communicated writing is not pretended to be a full and methodical hiſtory of mineral waters, but only a bundle of ſhort memoirs contributed towards the compiling of ſuch a work.

These, that they may be the more conveniently cited or referred to, I thought fit to divide into ſix ſections; whereof the firſt is introductory, and contains ſome general conſiderations about the occaſion, the ſubject, and ſome other things relating to thoſe memoirs. The ſecond contains only a ſet of titles for the firſt part of the propoſed work, becauſe urgent occaſions kept me from making, as I intended, ſome marginal notes upon ſeveral of the particular articles. The third exhibits a ſcheme of titles for the ſecond part of the propoſed work, *viz.* the way of experimentally exploring portions of a mineral water ſevered from the ſpring or receptacle. And becauſe the ſecond part is that, which I mainly deſigned, I have referred to it two other ſections, one, which is the fourth, containing a collection of experiments and obſervations relating to the uſual way of examining mineral waters by galls, as a ſpecimen given on the 13th title of larger annotations on the titles of the ſecond part, and the other conſiſting of leſs copious annotations, and ſometimes much ſhorter notes on divers other articles of the ſame ſecond part. To which, laſtly, is ſubjoined the ſixth ſection, conſiſting only of a ſet of articles referrible to the medicinal uſe of mineral waters; together with a concluſion addreſſed to the ingenious Doctor that ſet me upon this taſk. In proſecuting of which, I deſire it may not be thought ſtrange, that I have not cited authors, that have written of *Thermæ*, or of *Acidulæ*; for in the diſadvantageous circumſtances, wherein I wrote, I ſhould have been kept from conſulting them, if I had had them at hand; and I thought it enough for me, at that time, to impart to my friends, what my own experiments and thoughts had furniſhed me with, how little or mean ſoever that was. Which advertiſement is therefore the more fit to be here given, that I may not divert any from ſtudying thoſe more elaborate pieces, that have within no long time been publiſhed by ſkilful men, and eſpecially by the very learned Dr. Lister.

Short MEMOIRS for the Natural and Experimental Hiſtory of particular Mineral Waters.

SECT. I.

So many years, Sir, have paſt, ſince I had occaſion to conſider mineral waters, and opportunity to make trials on them with any application of mind, that, though ſince that time ſome virtuoſi have been pleaſed publickly to declare, that they found ſome directions they received from me not unuſeful to the examen of ſuch waters; yet, having forgotten many of my paſt thoughts, and loſt or miſlaid moſt of my memorials about matters of fact relating to thoſe liquors, I fear I ſhall not be able to ſatisfy either you, or myſelf, by what I now write about them. But however, ſince you will needs have me ſay ſomething upon this ſubject; ſince it is a noble one, as that wherein the health of thouſands is concerned; ſince it is of late grown to be more prized and diſcourſed of, than ever; and ſince, I have obſerved men's curioſity about it to have been confined to very narrow limits, moſt men contenting themſelves with the diſcoveries they can make by the infuſion of galls (or their body,) and perhaps a ſlightly improved evaporation: ſince, I ſay, I have theſe invitations to obey you, I am content to offer you my advices, ſuch as they are, for the drawing up of ſuch a natural hiſtory of a mineral water, propoſed, as being comprehenſive of many inquiries and ways of indagation, that even phyſicians have either not known or overlooked, may probably afford a more reaching notice, and inlarged knowledge of the ſubject treated of. Upon which account, I have, I confeſs, a deſire and an aim, though no great hope, that this rude eſſay may, by your improvements, and thoſe of your learned friends, be made of ſome ſervice to the public.

2. But here I muſt ingeniouſly own to you, that notwithſtanding the many ways I propoſe of diſcovering the natures or qualities of mineral waters, yet, I think the ſureſt way of knowing them, is a long and ſufficient experience of their good and bad effects. For, I ſtrongly ſuſpect, and it may be partly know, that there are, beneath the ſurface of the earth, divers mineral ſubſtances, ſome fixed, and ſome volatile, ſome in the form of hard bodies, ſome of ſoft ones, ſome of liquors, and ſome of fumes, divers of which the generality, even of learned men, are altogether ſtrangers to; beſides thoſe, that, though ſome men may chance to have ſeen, have their natures ſo little known, that they have not ſo much as names aſſigned to them. So that when I conſider, that of the ingredients we are unacquainted with (to paſs by all the reſt, that the earth may conceal) the

proportions, wherein they are mingled, may be numberleſs, and the qualities reſulting from theſe commixtures may be very differing from thoſe of the ſeparate ingredients; I am apt to look upon the difficulty of ſecurely determining the effects of mineral waters *à priori*, as little, if at all leſs than inſuperable to human underſtandings.

3. BUT this difficulty is not ſuch, as ought to make us think it uſeleſs to have a good project of the natural hiſtory of a mineral water. For it is no ſmall advantage, to know what particulars are fit for our inquiry, to be furniſhed with a ſet of heads, to which one may conveniently refer whatever he tries, or obſerves, about the ſubject propoſed: and (which is yet more conſiderable) to be furniſhed with variety of methods or ways, to make trials fit for inveſtigating the nature, or examining the qualities, of the propoſed water; ſince by the number and variety of purpoſely and fitly deviſed experiments, he that makes them may, as it were, view his ſubject on all ſides, and be much aſſiſted to conjecture, what ſaline, or other minerals known to us, and what quantities of them, do impregnate the water he examines, and conſequently what effects they are like to produce in human bodies.

4. THOUGH there be three ſorts of things fit to be taken notice of by him, that would give an hiſtorical account of a mineral water, whether cold or hot, yet contenting myſelf to treat but very curſorily of thoſe, that belong to the firſt and to the third of the three ſorts, I have made a more full and particular enumeration of the titles, that peculiarly belong to the ſecond ſort of obſervables; namely, thoſe, that mention the various trials, chymical and mechanical, that are to be made with the water after it is taken out of the ſpring. This I purpoſely did, chiefly becauſe it was only of this ſort of particulars, that you deſired my thoughts, and partly alſo becauſe they are moſt wanted and deſired by naturaliſts and phyſicians, and are like to prove the moſt inſtructive to them; having alſo this to recommend them, that to make the greateſt part of them by far, it is not neceſſary, that a man repair to the place, where the ſpring riſes, but he may at leiſure examine the water at home, where he may be accommodated with furnaces, veſſels, and other conveniences, to make his trials upon it.

5. A MUCH leſs diſcerning reader, than you, may perceive, that in forming the inſuing project of a natural hiſtory, I aimed much more to aſſiſt practical phyſicians to find the virtues and effects of mineral waters, than to inform ſpeculative naturaliſts of their cauſes and manner of being generated. But yet a heedful peruſer may find, that I have ſo endeavoured to gratify phyſicians, that I have not been altogether wanting [eſpecially in the firſt part, which is almoſt wholly mineralogical,] to the curioſity of philoſophers, as it relates to all ſorts of mineral waters; though you may eaſily enough diſcern, and readily confeſs it, that the following paper does much more regard thoſe cold ones, that from the acid taſte, that is found in moſt of them, are called *Acidulæ*, than thoſe other waters, that, from their heat, are commonly ſtiled *Thermæ*; becauſe the former ſort of mineral waters is that, which I have had the opportunity to be the more converſant in, as well as that, about which alone you have deſired my obſervations.

6. I HAD once thoughts of illuſtrating the following ſets of titles with a kind of *rationale*, briefly declaring the reaſon of their order and their number (for both theſe were conſiderately pitched upon, not lighted on by chance:) but I was obliged to omit it, when I found (as I quickly did) that I had too little leiſure and health, to employ much of either upon a troubleſome work of no greater importance. And therefore, knowing your perſpicacity to be more than ſufficient to make you diſcern ſome reaſon for the order, wherein I have marſhalled the articles of the laſt ſet of titles, which fall under the cognizance of your own profeſſion, I have not been ſollicitous to aſſign that reaſon. And I preſume it will be no great harm, if my haſte have made me alſo omit to perform at preſent the intention I had to make here and there ſome brief marginal notes upon ſome of the articles of the firſt part. And I thought it ſufficient (if not alſo capable of making ſome amends for the newly mentioned omiſſions) to make them ſomewhat numerous, and ſome of them large annotations upon the titles or articles of the ſecond part; this being indeed the chief, that I deſigned to inſiſt on, and preſent you.

7. I EXPECT it will be wondered at, that ſo many inquiries ſhould be propoſed, and ſo many things directed to be taken notice of, about a ſubject, that hath been thought ſo barren, that men are wont to think their curioſity great enough, if they inquire, what colours the mineral water will ſtrike with galls, or oaken leaves; and do obſerve, what kind and quantity of ſalt will remain after the evaporation of the liquor: and I much fear, that ſome, even of your profeſſion, will think I cut them out a great deal too much work, by ſo many troubleſome queries and trials. But I confeſs, that nature, or long experience, having made me, though not a ſceptical, yet a ſuſpicious and diffident philoſophiſer, I think myſelf obliged, on difficult occaſions, to aſk more than ten queſtions, before I preſume to anſwer one. Nor do I think, that the ſlightneſs of another's curioſity diſpenſes me from induſtriouſly exerciſing mine. I might on this occaſion repreſent, that though the greateſt naturaliſts and phyſicians among the antients did not only mention, but admire and diſcourſe of the loadſtone; yet our *Gilbert* thought fit to examine it further, and was thereby able to diſcover far more numerous phænomena, than all them put together had taken notice of; and I might add other inſtances to the ſame purpoſe. But, to anſwer more cloſely and

directly, *I ſay*, that to diſcover the nature of mineral waters being a thing far more difficult, than thoſe, that have not tried, do imagine, I think we ought to view the ſubject in as many differing lights as we can expoſe it to, and take in as many helps to diſcovery, as we can; ſince a great many particulars, that ſingly, or at the firſt view, ſeem not very pertinent, if they be conveyed in conjunction, and be ſkilfully applied, may much conduce to the deſired end. And, perhaps, hereafter, it will be found uſeful, if not neceſſary, to make large additions to the topics, whoſe number is now thought redundant: for the more qualities and other particulars we are acquainted with in any ſubject, the better grounded and the more enlarged knowledge we have of it. As for the trouble it may coſt to make the propoſed inquiries and trials, it may be ſaid, 1. that they are not all neceſſary (though uſeful) nor yet of equal moment; and therefore the omiſſion of ſome, that are leſs important, may not diſappoint the main ſearches. 2. I have purpoſely made moſt of the trials as eaſy and ſhort, as the matter and ſcope will permit; and thoſe, that will not undergo ſome trouble in ſeeking an uſeful truth, do not deſerve to find it, eſpecially ſince, in the chace of noble diſcoveries, as in hunting the nobler game, the toil oftentimes makes a part of the pleaſure. And I have made the leſs ſcruple to be ſomewhat ample in the inquiries I propound, becauſe divers obſervations have perſuaded me, that phyſicians ought to conſider very well both the nature of the waters they ordain, and to what perſons, for what diſeaſes, and in what manner they preſcribe the uſe of them: for though many look upon them as ſuch innocent medicines, as, if they do no good, can at leaſt do no harm; yet the effects, that have too often inſued the unſkilful uſe of them, eſpecially when it was long continued, allow me not to look upon the drinking of mineral waters as a ſlight thing, that may ſafely be plaid with, but as that, whereby we have ſeen, as very much good, ſo a great deal of miſchief, done, eſpecially ſome time after the operation is thought to be quite over, and perhaps almoſt forgotten.

8. I LOOK upon the examen of the properties and other qualities of mineral waters, as a thing, that is therefore of the greater importance, becauſe, I am apt to think, upon probable grounds, that, by a diligent inquiry, there may be diſcovered in *England* (and in divers other countries too) a far greater number, than is yet imagined, of mineral waters, eſpecially ferruginous ones; which I therefore gueſs will be found very numerous, becauſe, by ſome uncommon ways of trial, that I have employed, I have found, that divers minerals, that either men knew not what to make of, or, by reaſon of their paſſing under other names, did not ſuſpect to be martial, did yet partake of, and perhaps abound with, parts of a martial nature. And I ſhew, in another paper [*about the magnetiſm of the Earth*] that kindly provident nature, or rather its divine author, has, under various diſguiſes, furniſhed our globe with a far greater plenty and variety of iron ores and minerals, that partake of that metal, the moſt uſeful by far to mankind, than of any other metal. And as martial minerals do thus abound in the earth, ſo they are more diſpoſed, than one would ſuſpect ſuch hard bodies could be, to impregnate even ſuch liquors, as are not manifeſtly acid, and ſeem unlikely to be able to work upon minerals far leſs hard than they. To make this probable, we took not iron ore, or embryonated mars, but pure ſteel itſelf, the ſame as needles were made of; and upon the minute filings of it, we put ſome tincture of galls made with common water, and filtred through cap-paper, that the preſent colour of the liquor, and the change we expected to be made in it, might the better appear: and by this trial we found, that in leſs than an hour the tranſparent infuſion of galls was ſo altered, as to be grown not only opacous, but of a dark and almoſt inky colour, which it retained even after filtration; and this, though the vial, that contained it, was very ſlender. A not unlike effect was produced by ſmall filings of ſteel, but ſomewhat ſlowlier, in the red tincture of brazil, and that of logwood, made with common water.

9. I KNOW not, whether it may not be fit to be repreſented on this occaſion, that in countries manifeſtly abounding with metalline and other minerals, it may perhaps be worth while, that men's curioſity deſcend much lower than the ſuperficies or turf of the ground, and make ſearch both after ſubterraneal ſprings and wells, and their operations upon human bodies. For I have upon inquiry been aſſured by thoſe, that in ſeveral places have viſited mines, that they have met with in them, and ſometimes at very great depths, running, as well as ſtagnant, waters, of differing taſtes, and ſometimes other quality; and that the diggers venturing to make uſe of them to quench their thirſt, as they found ſome of them miſchievous (as corroſive, petrific, *&c.*) ſo they met with others, that were not only innocently potable, but medicinal. Of both theſe ſorts we have inſtances, in our tin-mines of *Cornwal* in *Devonſhire*: and of the latter ſort I received from an ingenious gentleman, that has the overſight of ſome *Corniſh* water-works, this memorable anſwer to an inquiry I ſent him. The ſtrangeſt account, ſays he, of mineral waters, that I have yet had, was of that in the bottom of a tin-work called *Karnkey*, wrought above 60 fathom [that is 360 foot deep;] the mineral being a mixture of tin and iron, and the water red and puddle, yet drunk was cool and not nauſeous, and would paſs by urine near as red as it was drunk, as I have been informed by thoſe, that drunk of it whilſt it [the mine] was working, being now ſtruck out, [that is, the vein of ore being degenerated, or loſt.] However, I believe experiments might yet be made with water much

of the ſame nature. Thus far he, from whom, notwithſtanding the remoteneſs of the place he lives in, I hope to get ſome of this liquor to make trial of; which if I do, I deſign you an account of the effects.

I could enlarge upon the ſubjects of theſe two laſt (the 8th and the 9th) numbers; but, after ſo long an introduction to ſhort memoirs, it is high time, that I come at length to ſet down the topics themſelves, that I deſign to propoſe.

SECT. II.

TITLES

For the natural hiſtory of a mineral water propoſed, conſidered as being yet in its channel or receptacles: (being the firſt, or mineralogical, part of the deſigned work.)

He, that would draw up the hiſtory of a mineral water, [to have its qualities, ſome examined and ſome inveſtigated,] ſhould, in my opinion, make three ſorts of obſervations about it. For firſt, he ought to take notice of thoſe particulars, that relate to it whilſt it is yet under ground, or in its native receptacles: next, he is to examine the properties and other qualities of it, when it is drawn up by men at the ſpring-head, or other receptacle: laſtly, he is to conſider the operations and effects of it upon human bodies, whether ſick or ſound, according to the ſeveral ways and circumſtances made uſe of in adminiſtring it.

To the firſt of theſe three ſorts of obſervations may be referred ſuch heads or titles, as theſe.

1. In what climate and parallel, or in what degree of latitude, the mineral water does ſpring up, or ſtagnate?

2. Whether the ſpring-head, or other receptacle, do chiefly regard the Eaſt, the Weſt, the North, or the South?

3. Whether the water be found in a plain or valley? And if not, whether it ariſe in a hillock, a hill, or a mountain?

4. And whether it be found at or near the top, the middle, or the bottom, of the riſing ground.

5. Whether the waters leave any recrement, or other unuſual ſubſtance, upon the ſtones, or other bodies, that lie in the channels they paſs through as they glide along, or the receptacles that contain them?

6. Whether there be beneath or near the medicinal water, any ſubterraneal fire, that hath manifeſt chimneys or vents, and viſibly (by night only, or alſo by day,) burns or ſmoaks, either conſtantly, or at certain periods of time?

7. Whether at or near the mouth, or orifice, of the abovementioned chimneys or vents, there be found either flowers of brimſtone, or a ſalt like ſal-armoniac, or ſome other mineral exhalations in a dry form?

8. Whether there be under or near the courſe or channel of the water, any ſubterraneal æſtuary, or latent maſs, of hot, but not actually, or at leaſt viſibly, burning matters? And whether ſuch æſtuary afford an uniform heat, as to ſenſe, or have periodical hot fits, as it were; and if ſo, whether theſe come at certain and ſtated times, or uncertainly or irregularly?

9. Whether it be obſerved, that over the æſtuary, or in ſome other neighbouring part of the place, where the mineral water ſprings, there ariſe any viſible mineral fumes or ſmoak, (which, when they do appear, are wont to do it early in the morning, or late in the evening,) and if ſuch fumes aſcend, how plentiful they are, of what colour, and of what ſmell?

10. What is the more obvious nature of the not manifeſtly metalline, nor marcaſitical part of the ſoil, which the medicinal water paſſes through or touches? And what are the qualities of the neighbouring ſoil, and the adjacent country? As whether it be rocky, ſtony, clayiſh, ſandy, chalky, *&c.*

11. Whether there be any ores, marcaſites, or earths, (eſpecially highly coloured ones) impregnated with mineral juices, to be met with in the courſe of the medicinal ſpring, or in the receptacle of the ſame water ſtagnant? And what theſe minerals are, whether copperiſh, ferrugineous, marcaſitical, *&c.* and whether the ores do, or do not, abound in the metalline portion? As alſo with what other ingredient, as ſpar, cauke, ſulphur, orpiment, arſenick, *&c.* (whether innocent or hurtful) they are mingled, or elſe compacted together?

12. Whether it can be diſcovered, that the ſpring of the medicinal water was common water before it came to ſuch a place or part of the ſoil it runs through, and there begins to be manifeſtly impregnated with mineral bodies?

13. And whether, in this caſe, it makes any efferveſcence, or other conflict, with the mineral it imbibes, or with any other water or liquor, that it meets with in its way; and whether the conflict produce any manifeſt heat or no?

14. Whether, if the mineral water propoſed be manifeſtly hot, or extraordinarily cold, the ſprings it flows out at, or the receptacle it ſtagnates in, have near it (and if, it have, how near) a ſpring, or well of water, of a contrary quality, as it is obſerved in very neighbouring ſprings in ſome few places of *France*, and elſewhere?

15. Whether, when the water appears in the ſpring or receptacle, there appear alſo, either floating at the top, or lying at the bottom, or ſwimming between both, any drops or greater quantity of oil, (like naphta or petroleum,) or ſome other bituminous and inflammable ſubſtance.

16. Whether the water be conſiderably altered, in quantity or quality, by the different ſeaſons of the year, as ſummer, winter, *&c.* by the much varying temperatures of the air,

as to heat, coldneſs, drought, *&c.* by the plenty, or paucity, frequency, or unfrequency, of falling rains, or ſnows; and what may be the bounds and meaſures of theſe alterations of the mineral water?

17. Whether any thing conſiderable can be certainly diſcovered, or any very probable conjecture made, of the nature and qualities of the ſubſtances, that impregnate the water, by chymically and mechanically examining the mineral earths, through which it flows, or in which it ſtagnates? And particularly, by obſerving their colour, whether native or acquired, by being kept in the fire; their ſpecific gravity; their affording, or not affording, any ſalt, or other ſoluble ſubſtance, by decoction; their being ſoluble, or indiſſoluble, in particular chymical menſtruums of ſeveral ſorts, as *aqua fortis*, ſpirit of ſalt, *&c.* and their being committed to diſtillation in veſſels of differing ſorts, and various degrees of fire, with care to receive ſeparately the differing ſubſtances they afford, whether in the form of liquors, or of flowers; and by examining theſe ſubſtances by fit and proper ways, as alſo the *cap. mort.* by calcination, elixiviation, and (if it will bear ſuch a fire) vitrification?

SECT. III.

TITLES

For the natural hiſtory of a mineral water propoſed, conſidered as being drawn out of its ſpring or receptacle: (being the ſecond, or phyſico-chymical, part of the deſigned work.)

That this ſcheme of titles may be the better underſtood, and the more inſtructive and uſeful, though I have not time to write an ample comment upon it all, yet I thought fit to illuſtrate moſt of its particular articles by ſuch notes, as may either explicate the meaning of what is but briefly couched, or deliver ſome of the practical ways of trial, that I make uſe of, on occaſion of the ſubject mentioned in the title or article, whereto the notes belong. Theſe being divers of them too large to be conveniently placed in the margin, are all of them ſet down together after this ſet of titles.

TITLE.

1. Of the actual coldneſs or heat of the mineral water propoſed.
2. Of the ſpecific gravity of the mineral water propoſed.
3. Of the tranſparency, the muddineſs, or the opacity of the mineral water.
4. Whether the mineral water will, by ſtanding for a competent time, let fall of itſelf any oker, or other earthy ſubſtance, eſpecially though the liquor be kept from the air?
5. Whether any thing, and if any thing, what can be diſcovered in the mineral water by the help of the beſt microſcopes adapted to view liquors?
6. Of the colour or colourneſs of the mineral water.
7. Of the odour of the mineral water, as acetous, winy, ſulphureous, bituminous, *&c.*
8. Of the taſte of the mineral water, as acid, ferruginous, vitriolate, lixivial, ſulphureous, *&c.*
9. Whether any change will be produced in the tranſparency, colour, odour, or taſte of the mineral water, by its being taken up at the ſpring-head or other receptacle; or removed to ſome diſtance, by its being kept ſtopped or unſtopped for a greater or leſſer ſpace of time; and, by its being much warmed or refrigerated, and alſo, by naturally or artificially produced cold, turned into ice, and thawed again?
10. Of the thinneſs or viſcoſity of the mineral water.
11. Whether the mineral water be more eaſy to be heated and cooled, and to be dilated and condenſed, than common water?
12. Whether the mineral water will of itſelf putrify, and, if it will, whether ſooner or later, than common water, and with what kind or degree of ſtink and other phænomena?
13. Of the change of colours producible in the mineral water by aſtringent drugs, as galls, pomgranate-peels, balauſtium, red roſes, myrobolans, oaken leaves, *&c.* as alſo by ſome liquors or juices of the body.
14. Whether any thing will be precipitated out of the mineral waters by ſalts or ſaline liquors, whether they be acid, as ſpirit of ſalt, of nitre, *aqua fortis*, *&c.* or volatile alcalies, as ſtrong ſpirit of urine, ſal-armoniac, *&c.* or lixiviate ſalts, as oil of tartar *per deliquium*, fixt nitre, *&c*?
15. How to examine with evaporation, whether the mineral water contain common ſalt, and, if it do, whether it contains but little or much?
16. How to examine, without evaporation, whether the mineral water have any acidity, though it be but very little?
17. Of the liquor or liquors afforded by the mineral water by diſtillation *in balneo*, and other ways.
18. Of the reſidence, *cap. mort.* of the mineral water, when the liquor is totally evaporated or diſtilled off; and whether the *cap. mort.* be the ſame in quantity and quality, if produced by either of thoſe ways?
19. Whether the propoſed water being, in glaſs veſſels exactly luted together, ſlowly and warily abſtracted to a thickiſh ſubſtance; this being reconjoined to the diſtilled liquor, the mineral water will be redintegrated, and have again the ſame texture and qualities it had at firſt?

20. Whether a glaſs full of the mineral water being hermetically ſealed, and boiled in common water, deep enough to keep it always covered, will have its texture ſo altered, as to ſuffer an obſervable change in any of its manifeſt qualities? And if it do, in what qualities, and to what degree of alteration?

21. Of the proportion of the dry *cap. mort.* to the mineral water, that affords it.

22. Of the diviſion of the *cap. mort.* into ſaline and terreſtrial, and other parts not diſſoluble in water, in caſe it contain both or more ſorts.

23. Of the proportion of the ſaline part of the *cap. mort.* to the terreſtrial.

24. Of the fixity or volatility of the ſaline part in ſtrong fires.

25. Whether the ſaline part will ſhoot into cryſtals or no? And, if it will, what figure the grains will be of? And, if it will not, whether being combined with a ſalt, that will (as purified ſea ſalt-petre, &c.) it will then cryſtallize; and, if it do, into what figures it will ſhoot, eſpecially if any of them be reducible to thoſe of any ſpecies of ſalt known to us?

26. To examine, whether the ſaline part be, *ex prædominio*, acid, alcaliſate, or adiaphorous?

27. Of the obſervables in the terreſtrial portion of the *cap. mort.* as, beſides its quantity in reference to the ſaline, its colour, odour, volatility or fixity in a ſtrong fire; its being ſoluble, or not diſſoluble by divers menſtruums, as ſpirit of vinegar, ſpirit of urine, oil of tartar, &c.

28. Whether, and (if any thing) how much the mineral water's earth looſes by ſtrong and laſting ignition? What changes of colour, &c. it thereby receives? Whether it be capable of vitrification *per ſe*? And what colour, (if any,) it will impart to fine and well powdered venice glaſs, if they be exactly mixed and fluxed into a tranſparent glaſs?

29. Of the oeconomical and mechanical uſes of the mineral water, as in brewing, baking, waſhing of linnen, tanning of leather, or dying of cloth, callicoes, ſilks, &c. as theſe may aſſiſt in diſcovering the ingredients and qualities of the liquor propoſed.

30. Of the imitation of natural medicinal waters, by chymical and other artificial ways, as that may help the phyſicians to gueſs at the quality and quantity of the ingredients, that impregnate the natural water propoſed.

AN
APPENDIX
Containing

1. Paralipomena, or things directly belonging to the hiſtory and pretermitted in it.

2. A chaos of obſervations and experiments, remotely or indirectly referrible either to one or more of the foregoing titles, or to the common ſubject of them all.

SECT. IV.

Experimental remarks upon the (uſual) way of examining mineral waters by the help of galls: delivered by way of larger annotations upon the thirteenth article of the ſecond part.

Since the change of colour, that mineral waters produce in the infuſion or tincture of galls, is the moſt uſual way, that many phyſicians, and the almoſt only, that ſome of them endeavour to diſcover or examine mineral waters by, it may be worth while, in this place, to ſet down ſome remarks, that I have made about this way of probation; and the rather, becauſe it may, *mutatis mutandis*, be not unuſefully applied to the exploring the qualities of mineral waters by colorations, though made with other materials than galls. Firſt then it may be obſerved, that one need not make an infuſion or tincture of galls in common water, to try if, by their means, a new colour will be produced: for I am wont to beat them to powder, and keep them in a glaſs (not too big) exactly ſtopped, by which means I have them always in readineſs to mingle with the mineral water, and alter the colour of it, if galls be able to do it, almoſt in a trice; whereas, to draw the tincture of galls with ſimple water, often takes up ſeveral hours, and the tinging parts are much weakened by being diluted by the menſtruum. If you would have a tincture, the powder of galls, tied up cloſe in a rag, and with it hung in the liquor, makes the infuſion leſs muddy. If you be in haſte, and have none of the powder at hand, you may ſcrape as much of a gall-apple, as you need, into the mineral water.

2. I have obſerved thoſe parts of the infuſion of galls, (eſpecially if made by heat) that produce the new colour with ferruginous waters, to be more apt to fly away than one would think, the infuſion becoming often unfit to alter the colour of the martial waters, whilſt yet itſelf appears ſufficiently high coloured. Upon which account I chuſe to make a tincture of galls not long before I mind to uſe it; and, if I employ dry galls, to take powder, that is not ſtale.

3. It is no ſafe way, and may be very erroneous, that is uſually taken in mixing galls, or their infuſion with the water to be explored, ſo careleſly, as is wont to be done. For thoſe, that are curious to make good ink, will eaſily believe, that much of the deepneſs of the colour depends upon the proportion of galls to the other ingredient; and accordingly, that by putting a much greater, or a much leſſer, quantity of galls into ſuch a quantity of the mineral water, the reſult-

ing colour may be more or leſs intenſe. To obviate which inconvenience, I take this courſe, when the occaſion deſerves it; I make my infuſion of galls with a certain weight of the powder in a determinate weight of water. As for inſtance, I put about five gr. of powdered galls, to ſteep for ſo many hours in an ounce of water: but if I make uſe of the dry powder, then I am wont to put three or four grains into an ounce of the liquor to be examined; which is a way far more certain, than the common, wherein the ingredients are eſtimated but by gueſs. I have mentioned various proportions of powdered galls to the ſame quantity of liquor, becauſe I have obſerved, that there is really a great inequality among the mineral waters, in which it may be put; and I have found by trial, that in an ounce of the *German* Spa, a ſingle grain of powder would immediately produce a ſufficiently deep purple colour.

It is an inconvenience, that not only galls, but the other drugs hereafter to be mentioned, impart a high tincture of their own to the common water they are infuſed in; and therefore it were to be wiſhed, and is fit to be endeavoured, that we had ſome drug, that, without imparting a colour to the common water it impregnates, would afford an infuſion fit to ſtrike a blackiſh or a purple colour with martial waters.

Though it be uſeful, yet it is not neceſſary, to employ galls to produce a colour in the mineral water propoſed: for beſides that it is known, that uſually, (though not always, as I have tried) the ſame thing may be done, but ſomewhat more faintly, with oaken leaves, we may ſucceſsfully enough ſubſtitute, for the ſame purpoſe, ſome other aſtringent vegetables, as dried red-roſe leaves, the peel, and (as we have tried) the juice of pomegranates; and (what I find to be a notable ſtiptick) the bloſſoms of the ſame plant, (which are vulgarly called in the ſhops *ballauſtium*:) to which may be added myrobolans, logwood, and ſome others, that need not now be mentioned, whoſe ſtrong infuſions have yielded me a tincture very dark and blackiſh with ſome martial liquors.

6. In regard that the galls, or other drugs, to be infuſed in common water, are not always of the ſame goodneſs or ſtrength, it is adviſeable not ſo to truſt to any determinate proportion of the pigment to the water, as not to take in the help of the eye to judge, by the colour of the tincture, whether the liquor be duly (and not too much or too little) impregnated.

8. Whereas there is an intimation in the cloſe of this thirteenth article of the preſent ſet of titles, that animal liquors may be employed to produce new colours with mineral waters, I gave that hint, not only becauſe it is uſually obſerved in martial waters, ſuch as thoſe of *Tunbridge*, the *Spa*, *&c.* that the groſs excrements of the lower belly are blackened by a commixture of their metalline parts; but in *Tunbridge* waters particularly I have obſerved, that after the drinking of larger doſes of them, the root of the tongue, and perhaps ſome neighbouring parts, would alſo acquire a dark colour, by the operation of the tranſient liquor.

Though the way of trying mineral waters by the change of colours, that galls produce in them, be uſeful and recommended by being eaſy, cheap, and expeditious, yet I do not take it to be either of that extent, or of that certainty, that it is vulgarly preſumed to be of: for its main, if not only conſiderable uſe is, to diſcover by ſtriking, or not affording, a black or blackiſh, or at leaſt a purple or a purpliſh colour, with a mineral water, to manifeſt the liquor to be, or not to be, either of a vitriolate, or a ferruginous nature. But there are divers metalline ores, and other mineral bodies, which, not participating of iron, will not, by this way, be diſcoverable, and yet may ſtrongly impregnate the water propoſed: as for example, to try, whether if arſenic were mingled with water, galls would diſcover it by producing with it a dark colour, I put ſome of the powder of them into a decoction of arſenic, but did not perceive, that it gave the liquor any deeper colour, than it would have done to common water. And as the extent of this explorer of waters is not very great, ſo neither do I find the informations it gives us to be ſo certain, as they are preſumed: for, if I much miſ-remember not, I long ſince found, upon trial purpoſely made, that another body of a metalline nature, and that did not partake of iron, would, with infuſion of galls, afford a very dark colour, that might eaſily, among ordinary beholders, paſs for the colour produced by a martial water: and I do ſomewhat doubt, whether ſo much as all liquors impregnated with iron will be diſcovered to be ſo by the colour they afford with galls; for I have ſometimes made ſuch a liquor with no mineral ſubſtance in it, ſave ſteel or iron, but I did not find it would turn the infuſion of galls either blackiſh or purple; which made me ſuſpect, that theſe colours are afforded only by ſuch martial waters, as have been wrought upon, more or leſs, by ſome acid ſalts or fumes.

9. Unto theſe things I ſhall add, that I found that to be a miſtake, which is generally taken for granted, *viz.* that the infuſion of galls will certainly diſcover, by becoming black, (or purple) if a mineral water, that is mixed with it, be vitriolate; for though it be true, that if in the vitriolated water iron, be the only or predominant mineral, or be at leaſt conſiderably participated by the liquor, yet if the diſſolved vitriol be altogether copperiſh, I found, by ſeveral trials purpoſely made with a ſtrong ſolution of Roman vitriol, (wherein copper is affirmed to be the only, or to be very much the predominant metal) that it would not, with infuſion or tincture of galls, afford either a black or a blackiſh colour, but only a thick and muddy one, that was not ſo much purpliſh.

It comes into my mind, upon this occaſion, that from one of the northern countries of *England*, where there are divers mineral waters, there was brought me by a virtuoſi a good quantity of very whitiſh earth, which he ſuſpected to be of a peculiar nature, but could not tell of what. This odd earth being examined, I concluded it to contain a conſiderable proportion of lead ore, corroded by ſome mineral ſalts, and embodied with the ſoil; ſo that if it had been in a place, where people had ſought for mineral waters, it is probable, that, finding ſome peculiarity in the taſte of thoſe, that paſſed through this earth, they would have taken it for a mineral water, but had been at a great loſs to determine what mineral it did partake of; and perhaps, in endeavouring to reſolve the doubt, by drinking it, they would have found very bad effects of it. But probably the ſulphureous ſpirit, to be e'er long deſcribed in this paper, would have informed them, that the water was impregnated with a body of the nature of vitriol, but not of common vitriol: for though galls do not give a black, or very blackiſh colour with a ſolution of *ſaccharum ſaturni* (which is indeed the vitriol of lead) reſolved in diſtilled or rain water; yet I found by trial, that this volatile ſulphur did manifeſtly and preſently do it; which trial I was fain to take up with, becauſe, when I had occaſion to conſider this matter, I had not at hand the ores of lead, copper, *&c.* and therefore was fain to content myſelf with the ſolutions of the metals themſelves in their proper menſtruums, it being probable, that the metalline parts of the ores would have afforded either the ſame ſolutions, or ſome very like them, in the ſame menſtruums; which conſiſting of niter, ſea-ſalt and vitriol, bodies that abound in diverſe places of the earth through which ſprings flow, the impregnated water would afford phænomena of the ſame kind. I made trials alſo upon a ſomewhat fine ſolution of refined gold made in an aqua regalis, and upon a ſolution of common running mercury made with aqua fortis, and in a clear ſolution of tin made, not with either of the foregoing menſtruums, (for I have not found them to diſſove it genuinely) but in a peculiar ſolvent, (which I have communicated in another paper) that does not only diſſolve it readily, but keep it permanently diſſolved, as aqua fortis does ſilver, but not tin. To theſe ſolutions I put galls, without obtaining any blackiſh colour, except from that, which contained gold. But with our ſulphureous liquor we produced notable changes of colour, and thoſe, in all the ſolutions but one, a dark one, or tending to blackneſs; and though, for that reaſon, a careleſs eye might judge them indiſcriminately to be blackiſh; yet, ſince I well remember, that the degrees, or ſome other modification, of the ſame dark colour ſeemed plainly enough not to be the ſame in all of them, I do not think it impoſſible, but that a very heedful beholder (which, when I made thoſe trials, I had no great motive to be) may diſcern between thoſe obſcure colours ſome little differences, that may much aſſiſt him to gueſs, what metalline ſubſtance is contained in the liquor, or at leaſt is predominant in it, if it be a compounded one. And I particularly remember, that the colour, that ſprang from our ſulphureous liquor and ſolution of tin, was manifeſtly diſtinguiſhable from thoſe produced in that of any of the other ſolutions, being not black or blackiſh, nor ſo much as purple, but of a kind of browniſh yellow.

THOUGH I am content, that the things I come from mentioning, ſhould make men cautious and diffident, yet not only I do not deſpiſe or ſlight the uſe of galls, *&c.* even as it is vulgarly practiſed, but I am apt to think, that the way of exploring mineral waters by the changes of colour, that may be produced in them or by them, when they are mingled with convenient drugs or additaments, may be made of greater extent and uſe, than he, that has read what I have written in the foregoing number, will perhaps be forward to expect. But to make the way of exploring mineral waters by colorations, of ſomewhat more general uſe and leſs uncertainty, I would recommend theſe things to the experimenter:

(1.) IT ſeems very fit, if not neceſſary, that he look upon the change of colours, both while it is producing, and when it is produced, in a good light, and with a heedful eye: for by this means he may diſcover ſeveral ſhades or varieties of the more principal colours, and ſome other circumſtances, that he could not elſe take notice of; and which yet may afford good hints (in reference to other minerals, as well as martial ones) to a ſagacious obſerver. And I have ſometimes fancied, that there may be a kind of phyſiognomy of many, if not moſt other natural bodies, as well as of human faces, whereby an attentive and experienced conſiderer may himſelf diſcern in them many inſtructive things, that he cannot ſo declare to another man, as to make him diſcern them too.

(2.) THE attention here encouraged may perhaps be made more inſtructive by a way, that I have ſometimes practiſed to vary the ſhades and other phænomena of colours produced with mineral liquors. This way conſiſts chiefly in preparing ſheets of white paper, by drenching them in a ſtrong infuſion of braſil, logwood, or ſome other convenient dying ſtuff, and then letting them dry leiſurely in the air, which may give ſome of them, as I have obſerved, a colour differing enough from that of the liquor looked upon in a vial or drinking-glaſs. Upon this dry paper ye may let fall, but not all on the ſame place, ſome drops of the mineral liquor to be examined, eſpecially if it be of a ſaline nature; and by the changes of colour effected by theſe drops on the parts of the paper they fell and ſpread themſelves upon, a heedful obſerver may be aſſiſted to gueſs, what kind of mineral impregnates the liquor, and how much it does ſo; eſpecially if, on the ſame ſheet of paper, ſome other fit mineral water, or idoneous liquor, be likewiſe dropped, that the changes of colours produced by the two fluids may be ſurveyed and compared together. I alſo practiſed another way ſomewhat differing from this; as the main part of which we prepared white paper, by rubbing well upon it, with a hare's foot, or ſome ſuch thing, ſome idoneous powders, eſpecially that of vitriol (whereof, for this purpoſe, Engliſh ſeemed the beſt) lightly calcined in a gentle heat, till it became of a greyiſh colour and friable between the fingers. By this means it was eaſy to make the paper fit for our turn: for the finer parts having lodged themſelves in its pores, without much diſcolouring it, when the ſuperfluous duſt was ſtruck off, it became capable of affording a variety of colours, or rather ſhades, ſome deeper and ſome fainter, when I let fall on it ſome drops of differing martial liquors. But of the examen of the *materia medica*, by the changes of colour produced in it or by it, more is ſaid in another paper; and therefore, inſtead of transferring that hither, I ſhall here briefly intimate, that divers variations of colour may be made, either by infuſing or otherwiſe mixing, as I have ſometimes done, ſomething in the mineral water before the tinging ſtuff be put to it; or by putting ſomewhat in the infuſion or powder of galls, before it be mixed with the mineral water; or elſe by dropping fit liquors (ſuch as ſpirit of ſalt firſt, and then ſpirit of urine, or oil of tartar) into the blackiſh or purple mixture of galls, and the medicinal water to be examined: for by theſe means diverſe variations of colours may be obſerved, which, together with ſome other ways, that I have made uſe of to multiply them, I have not now leiſure to ſet down.

(3.) It is not convenient to confine one's ſelf to the uſe either of galls or oaken leaves, but to make uſe alſo of red roſes, *balauſtium*, logwood, braſil, and other aſtringent vegetable pigments. For though ſome of theſe give a deeper tincture than galls, yet, by the diverſity of colours produced by them in mineral waters, an attentive beholder may, as was lately intimated, where I mentioned diverſity of lights and ſhades, diſcover ſome things, that he would not be informed of, or receive any hints of, by the help of galls or oaken leaves alone. Nay, I would not have our experimenter employ none but vegetable ſubſtances about his colorations, but ſometimes make uſe of animal ones, and (more often) of minerals; ſince, by this means, he may much diverſify his trials, and increaſe the number of phænomena, ſome of which he may probably find inſtructive. Beſides aſtringent plants, I have found, and ſometimes deviſed, other ſubſtances, that will turn black, as well as galls, with vitriolated water; and that not only with thoſe, that are richly impregnated with iron, but alſo with thoſe, wherein copper alone abounds, as in Roman vitriol. And though, for certain reaſons, I muſt not now ſet down a way I have, to diſcover in a trice both theſe vitriols, without any liquor or tangible body, yet I ſhall ſubjoin, as a kind of *ſuccedaneum*, that may ſuffice for the preſent occaſion, the way of making a liquor, that will preſently turn black with a ſolution either of martial or cupreous vitriol.

“Take equal parts of pure ſalt of tartar, and either flowers of ſulphur, or at leaſt ſulphur finely powdered, and good ſal-armoniac; reduce the firſt and the laſt to powder ſeparately, melt the ſulphur over a gentle fire, and by degrees put to it the ſalt of tartar, ſtirring them well, to make them incorporate and grow red, (or reddiſh:) then put this mixture pulveriſed into a glaſs retort, or a cucurbite, and pour on it the ſal-armoniac diſſolved in fair water; and, cloſing well the junctures, diſtill all in ſand by degrees of a moderate fire, ſhifting the receiver once or twice, becauſe the liquors will be differingly tinged and ſtrong; and that, which aſcends laſt, may bring over but very little of the ſulphur, whoſe volatile tincture is yet the main thing we aim at in this operation.”

(4.) I do not deſpair, but that he, who were able to make a ſkilful uſe of the ſeveral drugs and other bodies, vegetable, animal and mineral, that may produce new colours in, or with, mineral waters, (or, in ſome caſes, with the ſubſtances, that impregnate them) may, by their means, be alſo enabled to diſcover the preſence or inexiſtence of divers other minerals, ſome of them ſalubrious, or at leaſt ſafe, and ſome others either hurtful, or at leaſt dangerous, that are not taken notice of by thoſe, that content themſelves to employ galls and oaken leaves in the exploration of the waters they examine: for ſome of theſe liquors contain ſalts, that, having not corroded either martial or cupreous ores, or marcaſites, do not betray themſelves by producing either an inky or a fainter degree of blackneſs, or elſe a purple, with the drugs made uſe of to change their colours. Of theſe ſalts I have met with more than one ſort, which may be more properly taken notice of, when we conſider the mineral water, and its contents.

12. I think it likewiſe very poſſible, that induſtrious men ſhould find ways to diſcover, by the help of the change of colours, whether orpiment or native arſenick, or the like poiſonous minerals, do ſo impregnate the water propoſed, as to make it very hurtful or dangerous, though not abſolutely pernicious. And as for ſulphur, there may be ſeveral waters, that partake of it, without being taken notice of to do ſo. For I remember, that I have ſometimes purpoſely made a liquor, that was limpid and colourleſs like ſpring water, and which would totally fly up, even with a gentle heat; and yet this liquor was richly impregnated with a mineral ſulphur, as I convinced ſeveral virtuoſi by manifeſt and ocular proofs. So that if ſulphur chanced to be combined with any ſalt or mineral, of thoſe many ſubterraneal ones, that nature

hath hid from us, that can ſuppreſs or diſguiſe its peculiar odour, the water may be conſiderably, and yet unobſervedly, impregnated with it. And yet it is like, this may eaſily be diſcovered by the change of colour producible in ſuch a ſulphureous liquor by vitriolate bodies, and other appropriate additaments: which may be thought the more probable, becauſe, though the ſpirit lately deſcribed be very tranſparent and totally volatile in the form of a liquor ſometimes pale enough, yet common Engliſh vitriol, as alſo that of *Dantzick*, which is venereal, will preſently turn it of a black or very dark colour. And to add here ſomewhat more difficult to be performed, I have deviſed a way, which I elſewhere deliver, whereby it may appear, that even copper, that hath been melted into a body, may be ſo ſubtilized and diſguiſed, as to have a multitude of its metalline parts made to aſcend with others in the form of a tranſparent liquor like common water; and yet by putting to it a little of another ſubſtance, as volatile and colourleſs as itſelf, it would preſently diſcloſe the copper it contained, by turning blue as a ſapphire.

A Paper referred to certain obſervations about the ſalubrity and inſalubrity of the air, under whoſe 4th propoſition this proceſs is ranged.

13. BECAUSE arſenic is a very pernicious drug, and yet has been ſuſpected to be clandeſtinely mingled with ſome mineral waters, which I thought the leſs improbable, becauſe ſome of the marcaſitical bodies, by which ſome minerals paſs, are judged not to be devoid of arſenic; for theſe reaſons, I ſay, and for this other, which makes the mention of it pertinent in this place, that galls did not (as I elſewhere note) diſcover at all the inexiſtence of this poiſonous drug in water, though the liquor were copiouſly impregnated with it, I thought fit to make ſome trials, that ſeemed to me likely to diſcover at once the inexiſtence of arſenic in water, and ſomewhat of the nature of that dangerous mineral.

HAPPENING ſome years ago to taſte arſenic, not without ſome little danger and inconvenience, the taſte of it did not ſeem to me to favour the vulgar ſuppoſition, that its poiſonous nature conſiſts in a highly acid ſalt; whereas its taſte agrees well with my conjecture, who ſuſpect it to be of an exceeding corroding or fretting nature, but whoſe corroſiveneſs is *ſui generis*, that is, of a peculiar kind. Having then made a ſtrong ſolution of arſenic in common water, [which does not without ſome ſkill eaſily diſſolve it,] we mixed a ſmall proportion of it with the German Spa water, and then dropping into this mixture ſome highly dephlegmed ſpirit of urine, we perceived a light lacteſcence to be produced, and a whitiſh precipitate very ſlowly to ſubſide.

WE found alſo, that a little (excellent) oil of tartar *per deliquium*, being dropped into ſome of the lately mentioned ſolution of arſenic, produced a heavy whitiſh cloud, which preſently ſettled at the lower part of the glaſs. We alſo put oil of vitriol, as one of the ſtrongeſt acids we know, into the ſolution of arſenic, but did not perceive, that the oil made a precipitation, or wrought much otherwiſe on it, than it would have done upon common water. And by theſe three trials one would ſuſpect, that arſenic is, at leaſt *ex prædominio*, an acid body.

BUT not content with theſe, we put ſome of the arſenical liquor upon ſome ſyrup of violets, and found it to change the ſyrup, though but ſlowly, rather to a green than a red or purple colour.

WE put to another portion of the ſame liquor ſome of our volatile ſulphureous ſpirit, but took notice of no precipitation, that enſued.

FOR a ſeverer examen we imployed a trial, that we ſucceſsfully make uſe of (and have delivered in another paper) to diſcover ſuch ſlight degrees of acidity in liquors, as by ordinary trials are not diſcoverable; but we could not, by this way, diſcern the leaſt acidity in our arſenical ſolution, but rather a manifeſt token of an urinous or lixiviate quality.

WITH the former experiment agreed very well that, which we afterwards made, by putting ſome of the arſenical liquor into a ſtrong ſolution of common ſublimate made in fair water. For by this means we had a copious precipitate, ſuch as might have been expected from an alcaline precipitant; and this was not brick-coloured, as fixed alcalies produce with diſſolved ſublimate, but white, ſuch as urinous or volatile alcalies (as they call them) are wont to make with the ſame liquor.

THE foregoing trials having been made at one time, when I was in haſte, and not at all fond of having to do with arſenic, (for which reaſon I cauſed the ſolution to be preſently thrown away to prevent dangerous miſtakes;) though what I have hitherto tried ſeems very favourable to our propoſed conjecture; "That though arſenic be a very
"corroſive body, and perhaps upon that
"ſcore poiſonous, yet its deleterious nature
"does not conſiſt only, or mainly, in a tran-
"ſcendently acid, nor in a lixiviate cauſtick
"quality, but in a corroſiveneſs *ſui generis*,
"I mean peculiar and diſtinct:" yet I ſhall forbear to be poſitive in this conjecture, till further trial, pretending only, by what has been ſaid, to ſhew the need of examining the vulgar ſuppoſition by further inquiries, and to give ſome hints towards the finding of antidotes againſt this cruel poyſon.

I SHALL now add, that for the ſake of water-drinkers I caſt about in my thoughts for ſome way, that might be of uſe, though of no certainty, in examining a mineral water ſuſpected to contain arſenic. To which purpoſe, for reaſons, which haſte forbids me to mention, I pitched upon vitriolate bodies, and found, that if a little ſolution of *Dantzick* vitriol were put to a convenient quantity of arſenical liquor, there would preſently enſue a great change of colour, and a dark ſubſtance would by degrees precipitate itſelf, and ſettle in the lower part of the glaſs. The like effect we found, when we put Engliſh vitriol.

vitriol, which (having no copper added in the making, as that of *Dantzick* has,) is either altogether, or almoſt totally, martial, into a conſiderable proportion of the arſenical ſolution.

I fear I ſhall be thought to have dwelt by far too long upon this one (13) article of our ſet of titles: but I was tempted to do it, partly, becauſe I thought the ſubject ſeemed both to merit and to need it; partly, becauſe I thought fit to give an inſtance, that may ſhew, that even that part of the exploration of mineral waters, that is judged to be the moſt cultivated, hath been but ſuperficially enough conſidered; and partly too, becauſe my want of health, and my preingagement to ſome ſubjects, that I am more concerned for, than I am for that I now treat of, permitting me to make few other than ſhorter notes upon the particular articles and clauſes of this ſcheme of titles; I thought it not amiſs, by referring all the foregoing obſervations and trials to the ſame topick, to give one ſpecimen (though but an imperfect one) of thoſe, that, for diſtinction's ſake, I ſtile Large Annotations. And though the title theſe belong to be the thirteenth in the ſcheme (of the II part,) yet I thought fit to premiſe theſe notes to all the reſt, though divers of them be on titles antecedent to the thirteenth; becauſe one or other of the many particulars referred to this laſt named title may probably be of uſe to you, in conſidering many of the other articles of this ſcheme, whether they follow the thirteenth, or precede it.

MARGINAL NOTES for the II. or phyſico-chymical part of the natural hiſtory of a mineral water propoſed.

Notes on the firſt title.

I. 1. THE article mentions actual coldneſs and heat, becauſe we do not here conſider that, which the ſchools call potential.

2. THE knowledge of the degree of coldneſs in the water, eſpecially if it be extraordinary, may ſomewhat aſſiſt the examiner to gueſs, whether the ſpring come from ſome notable depth under ground before it aſcends, or whether it runs through a ſoil abounding with ſalt-petre or ſal-armoniac, or ſome ſuch very refrigerating ſubſtance.

3. THE degree of coldneſs or heat may be eſtimated ſeveral ways; as, if the water be cold, by its having, or not having, the power to coagulate eſſential oil of anniſeeds, or that of fennel-ſeed; and if it be that, by its being, or not being, able to melt bodies of ſomewhat differing diſpoſitions to fuſion, as butter, tallow, bees-wax, &c. or to coagulate the whites of eggs, or to boil eggs in the ſhell, &c. But the beſt way is to plunge into the water propoſed at leaſt the whole ball or globulous part of a good hermetically ſealed thermoſcope, whereon the degrees of cold and heat are carefully marked.

Notes on the ſecond title.

II. THE knowledge of the ſpecifick gravity of a mineral water may be of great uſe to him, that endeavours to diſcover its nature, not only as this knowledge enables him to diſtinguiſh the propoſed water from others, but becauſe it may afford him a conſiderable and double information. For, by comparing the weight of the propoſed liquor with that of common water, he may be, in caſe the former be heavier, (as it uſually happens to be,) aſſiſted to eſtimate, what proportion of ſalt, or martial, or other mineral ſubſtance, it is impregnated with. And if it be very light, and much more if it be lighter than common water, he may probably conclude, that the ſubſtance, that impregnates it, is either very ſmall in quantity or proportion, or is not near ſo groſs, as is to be found in other mineral waters, but of a ſpirituous and volatile nature, which is a diſcovery of no ſmall moment in this affair. And though that may ſeem a paradox, which I here ſuppoſe, that a water impregnated with a metalline or mineral ſubſtance ſhould be as light, or even lighter than common water; yet upon trial carefully made I have found ſome mineral waters, as particularly that of *Tunbridge* well taken up, and (though they be ſomewhat leſs light) that of the German Spa, and of ſome of the *Iſlington* ſprings, to be manifeſtly lighter, than common water; and ſome taken up at *Tunbridge* I found to be lighter, than common water, even purified by diſtillation.

AND though it be very hard to conceive, yet I think it not impoſſible, that a ſubterraneal ſubſtance, that impregnates water, ſhould be lighter *in ſpecie* than it; but yet I would not refer this ſurprizing levity, in all caſes, nor all of it in moſt caſes, to the admixture of lighter corpuſcles; becauſe ſome trials juſtified the ſuſpicion I had, that much of the comparative lightneſs proceeded from this, that the mineral water was imbued with a ſmaller quantity of vulgar or culinary ſalt, than common water uſes to contain. But yet theſe trials did not ſatiſfy me, that this paucity of common ſalt was the ſole or adequate cauſe of the lightneſs of the mentioned waters.

BUT, to diſcover ſuch minute differences, one muſt have good inſtruments; and indeed, to ſpeak freely, there are few, upon whoſe reports I durſt confidently rely for the ſpecifick gravity of mineral waters; for to weigh liquors any thing exactly, there is requiſite more heedfulneſs, and more ſkill, and better inſtruments, than are eaſy to be met with together, and than we uſually imagine. And when phyſicians and others weigh mineral waters, they are wont to do it in ſome apothecary's or other tradeſman's ſhop, where, if the balances be ſmall, the veſſels and the water are commonly too heavy for them, and oftentimes wrong them. And if, as is uſual, the bottles or other veſſels be great, they require far better balances, than are uſually employed in the ſhops of apothecaries or grocers, whoſe balances a critical examiner will too often find to be far from being accurate; inſomuch that uſually, without at all altering the weights, though perhaps not great ones, he may eaſily make which ſcale he pleaſes manifeſtly preponderate, and continue in that poſition, and may as eaſily afterwards give the other ſcale the ſame advantage. The diligent and experienced mathematician *Merſennus* much complains of the difficulty he found to weigh liquors exactly, even by the help of his nicer inſtruments. The accurateſt way I know, is by comparing the differing weights, that the ſame ſinking body has in common water and in the liquor propoſed. But this way (which I elſewhere circumſtantially deliver) requiring, beſides good inſtruments, ſkill in hydroſtaticks, is practicable but by few. And the way of comparing waters, by the greater or leſſer ſinking of the ſame cylinder or other ſwimming body into them, is ſcarce accurate enough: wherefore, I choſe to make a very ſkilful artiſt blow, at the flame of a great lamp, a thin round vial with a flattiſh bottom, that it might ſtand upright, and be very light; and this was furniſhed with a neck as large as a gooſe quill, drawn very even into a hollow cylinder of above three inches long, and fitted at the top with a little gap, that hindered the water from aſcending above the due height.

THIS glaſs contained ℥iijſs. and 43 grains of common water, and yet, when empty, weighed but ʒvi + 42 grains: ſo that I could uſe it, when full of liquor, in ſuch a balance, that the addition or detraction of half a grain, or leſs, would make either ſcale preponderate. The length and evenneſs of the ſtem was deſigned for uſes not needful to be mentioned here, where it may ſuffice for my purpoſe to ſay, that this glaſs was judged capable of holding water enough for not uncurious trials, and yet not to be, though well filled, too heavy for a tender balance. In this veſſel therefore we carefully weighed ſeveral liquors (whoſe gravity belongs not to this place) and among them divers mineral waters, ſome of which, at leaſt known here at *London*, were found to be of the annexed weights.

THE glaſs being filled with ſeveral liquors to the ſame height, and weighed in the ſame balances;

	Ounces	dr.	gr.
Common water was found to weigh	3	4	43
Common water diſtilled	3	4	41
Acton water	3	4	48 ½
Epſom water	3	4	51
Dulwich water	2	4	54
Straton water	3	4	55
Barnet water	3	4	52
North-hall water	3	4	50
The German Spa-water	3	4	40
Tunbridge water	3	4	38
Iſlington water from the muſic houſe	3	4	36
Iſlington water from the vault with ſteps	3	4	39
Iſlington water from the cellar	3	4	39

BY this ſhort account it may appear, that, as divers mineral waters (that contain ſalts in them) are conſiderably heavier, than common water, ſo ſome, eſpecially ferruginous waters, are impregnated with ſo fine a ſubſtance, as to be lighter than common water.

Notes on the fourth title.

IV. THIS article may, in divers caſes, give ſome light to the diſcovery of the kind of ſoil, through which the water has paſſed; and is alſo uſeful to diſtinguiſh the ſpontaneous reſidence, if I may ſo call it, that the liquor lets fall by meer ſtanding, from that, which they call the *caput mortuum*, that remains after the total evaporation of the water; by which means alſo the weight of this laſt reſidence may be more truly known. Beſides ſome other mineral waters, I found, that the German Spa waters, brought very well ſtopt to *London*, afforded, by long ſtanding, a pretty quantity of terreſtrial ſubſtance, that looked almoſt like yellow oker, and perhaps was of great affinity to it in nature. 3. That clauſe in the article, *though the liquor be kept from the air*, was therefore ſet down, becauſe I had found by trials, that ſome liquors, by being expoſed to the free air, would have copious, and ſometimes ſurprizing ſubſtances, ſeparated from them; as if the air contained ſome precipitating ſalts fit to work on the liquors, ſo as to make in them ſuch notable ſeparations.

Notes on the fifth title.

V. AN accidental weakneſs I had in my eyes, when I had the beſt opportunity to endeavour ſatisfying myſelf about this inquiry, forced me to leave the proſecution of it to others. Only two things I ſhall take notice of on this occaſion: one is, that having cauſed one, that had young eyes, and was accuſtomed to make uſe of ſuch microſcopes, as are mentioned in the article, to look upon ſome mineral waters through them, he ſaid he could diſcern no difference between them and common water: notwithſtanding which, the trial ought to be repeated by various perſons, on ſeveral waters, with differing engyſcopes, and in differing lights, and other circumſtances. The other is, that whereas it is by divers learned men objected againſt the goodneſs of theſe magnifying glaſſes we now make uſe of to look on liquors, that the little bodies, that the ingenious Mr. *Lewenhoeck* and, ſince him, divers other virtuoſi have obſerved in water, wherein pepper has been infuſed, are not, as he pretends, living creatures, but little inanimate concretions, that are caſually formed, and carried to and fro in the liquor; to convince theſe doubters, of whoſe number I was myſelf at firſt inclined to be, I deviſed the following experiment: having laid upon the magnifying glaſs a part of a drop of water, wherein I could ſee ſtore of theſe little animals friſking up and down, we put to the liquor, with a briſtle or ſome ſuch very ſlender thing, part of a drop of ſpirit of ſalt, which, as was expected, preſently killed theſe little tender creatures, and, depriving them of their animal motion, left them to be carried ſo ſlowly to and fro in the liquor, as to make it viſible, that they were then dead, and had been before alive.

Notes on the ſeventh title.

VII. 1. The odours of divers mineral waters are beſt judged of at the ſpring-head or other receptacle, whence ſome of them being removed ſcarce afford any odour at all (perceptible by us men.)

2. Perhaps the ſulphureous ſcent, that is ſometimes perceived in *Tunbridge* and ſome other waters in their ſources, may in part proceed from looſe exhalations, that caſually happen to be mingled with the waters, but do not conſtantly belong to it.

3. The winy odour is mentioned among others; becauſe I am credibly informed, that in *France* there is a mineral ſpring, if not more or leſs than one, that has ſuch a ſmell.

4. I mention the bituminous odour diſtinctly from the ſulphureous, becauſe men are too apt to confound them, and take all ſtinking mineral waters for ſulphureous, whereas divers are manifeſtly bituminous; as may be gathered, to omit other ſigns, not only from their proper odours, but from more or fewer drops of petroleum, or a kind of courſe naphta, that are found ſwimming upon the water.

5. I think it alſo not unlikely, that ſometimes a ſpring may partake both of ſulphur and bitumen, mingled together by the ſubterraneal heat, ſince I have found, that I could eaſily melt and incorporate theſe two ſubſtances here above ground.

Notes on the ninth title.

IX. 1. This is an almoſt neceſſary article, becauſe many perſons, that drink mineral waters, cannot well, either for want of ſtrength or conveniency repair immediately to the ſpring-head, but are obliged to drink them in their beds or their lodgings, and perhaps to have them tranſported to a great diſtance, or even to another country. 2. Many purging waters are found to retain their laxative virtue, and that perhaps for a conſiderable time, though they be tranſported to places diſtant from thoſe they riſe in. 3. In ſuch ferruginous waters, as are lighter than common water, I found a manifeſt difference in reference to tranſportation; for moſt of them, even ſuch as will bear removing, have ſomething of freſhneſs and quickneſs at the ſpring-head, (perhaps from ſome ſpirituous and fugitive exhalations, that there ariſe with them, but preſently vaniſh,) that they have not any where elſe; and ſome do not only loſe this briſkneſs by being removed, though in veſſels well ſtopt, but they loſe alſo the power of producing, with the powder of galls, a purple colour, as I found by trial purpoſely made in more than one of theſe mineral waters; which, to prevent fraud, I ſent for to the ſprings themſelves by ſervants of my own: for though theſe carried their glaſs bottles along with them, and had no other errand there but to fill and ſtop them carefully, yet, by being tranſported leſs than one league, I found them ſo altered, that they would no longer make a purpliſh colour with powdered galls, but a deep reddiſh one; whereas the German Spa waters did almoſt always here in *London* afford me, with the ſame powder of galls, a rich purple colour; and Tunbridge waters afforded me the like, but not ſo deep a one, when I received them at *London* very well ſtopt. 4. This laſt clauſe was not to be omitted, becauſe the exact or negligent cloſing of the veſſels, wherein ſuch waters are tranſported, is a circumſtance of great moment. For more than once I received at *London* waters ſent me from *Tunbridge* by phyſicians themſelves, (who uſed at leaſt a moderate care in putting them up,) which yet would by no means afford with galls a purpliſh colour. And I found, that even the German Spa-water would almoſt preſently loſe its capacity of being made purple by galls, if it were conſiderably heated. 5. But the ſame Spa-water being, in ſummer time, kept all night in an open veſſel, did the next morning, till it was late, if not till noon, retain a diſpoſition to be made purple by the admixture of galls; but that diſpoſition it loſt before the next day.

Notes on the fifteenth title.

XV. 1. Becauſe it often happens, that men have not the leiſure and the conveniency totally to evaporate the propoſed mineral water, it may be an uſeful thing to be able, without evaporation, to diſcover, whether it contain any common ſalt; and, if it do, to make ſome eſtimate, how copiouſly or ſparingly the liquor is impregnated with it. This might eaſily be done with nicety enough, if I were not by very juſt reaſons reſtrained, for a while, from communicating that way of examining the ſaltneſs and freſhneſs of waters; of which, I did, by the king's command, ſhew his majeſty ſome proofs, whereof mention was preſently after made in the printed Gazettes. But till it be free for me to impart that way to the public, I ſhall only intimate, that ſome gueſs may be made at the ſaltneſs of waters, by obſerving, whether they will lather with waſh-balls or ſoap, and, if they will not, what quantity of curdled matter they will produce; as alſo, whether the waters will ſerve for waſhing of linnen, and will boil peas tender? Which two are the moſt uſual ways, that many ſeamen take to examine the goodneſs of unknown waters by. In divers purging waters this way may be difficult to be practiſed with certainty, becauſe of other ſalts, that may be predominant in them; but in the examen of lightly ferruginous ſprings it may be more relied upon. 2. It may not be unworthy obſervation, that, when I made uſe of my own way of examining the ſaltneſs of mineral ſprings, I did not find even the lighteſt ſort of them devoid of common ſalt; which I found, but not in equal proportions, to be contained not only in the ſeveral waters of Iſlington, Hampſtead water, and, if I miſremember not, in ſome others, but alſo particularly in Tunbridge waters, and thoſe of the German-Spa; which I did not much wonder at, becauſe I had long known, that more or leſs of common ſalt is very uſually harboured, though not obſerved, in many ſoils, through which all ſorts of ſprings, and conſequently mineral ones, have their courſe.

Notes on the ſixteenth title.

XVI. THOUGH acidity be ſo uſually a manifeſt quality of mineral waters, that authors are wont to divide them into *acidulæ* and *thermæ*; yet I have found by ſeveral trials, that it is not near ſo eaſy, as men preſume, to find a manifeſt acidity in all mineral waters, that are not ſulphureous or hot. For ſeveral ferruginous waters having probably ſpent the acidity they had upon the iron ore, which they diſſolved in their paſſage, retain ſo little acidity, that it is hard to diſcover they have any, either by their working upon coral, or by any conflict with ſpirit of urine, or the like, or by mixing them with ſyrup of violets, to change the colour of it; inſomuch, that ſometimes I ſhould have concluded ſome ſuch waters to have no acidity at all, if I had not had a way of diſcovering a far leſs degree of it, than I could diſcern it to have by other trials. The circumſtances, that made this way of examining ſo critical, will coſt me too many words to ſet down here, and I have done it in another paper expreſly written of the way of diſcovering the qualities of divers bodies, by changes of colour made in or with them: and therefore I ſhall here but briefly tell you, that I diſcover the acidity of liquors by their operation upon the colours of an infuſion of lignum nephriticum made in limpid water, (and ordered after a certain manner.) By this means I found the German-Spa to retain a little acidity, even here at *London*; but more than one of our own ferruginous ſprings did not, even upon this trial, appear to have any: and (which ſome may think ſtrange) I did not find even ſome of the purging ſprings, particularly that of *Acton*, to have any diſcernible acidity.

Notes on the twentieth title.

XX. THE ſcope of this inquiry was twofold: the firſt, to diſcover, whether a change of texture would notably alter the qualities of the liquor, when the hermetical ſeal hindered the avolation of any ſaline, ferruginous, or ſpirituous parts: and the other was to ſee, whether ſuch an agitation by heat, as in the open air would, as I had found, deprive the Spa-water of the virtue of making a purple colour with galls, would cauſe any manifeſt ſeparation of parts in the liquor, and make any groſſer ſubſtance to precipitate or ſubſide. But though we did twice (not without difficulty) make the experiment with Spa-water, yet we made it without ſucceſs; for the firſt time the glaſs broke at the bottom, before the water we immerſed it in was near boiling hot. And though the other glaſs reſiſted longer, and endured a greater heat, yet in not very many minutes that alſo broke at the bottom; which diſappointment a faithful hiſtorian ought as little to conceal as better ſucceſſes. And I chuſe to leave this 20th article of inquiry in its place, among the reſt of the titles, becauſe poſſibly ſome other may be more happy, than I was, in endeavouring to anſwer it. And I hold it not amiſs, in drawing up platforms of natural hiſtory, to ſet down what queſtions we think fit to be propoſed to nature; becauſe we cannot be ſure, before endeavours for trial be uſed, whether the thing to be attempted be practically performable, or not.

Notes on the twenty-ſixth title.

XXVI. 1. DIVERS ways may be propounded to diſcover, which of the qualities, mentioned in this article, is predominant in the ſalt to be examined; but, I confeſs, I ſomewhat doubt, whether theſe ways of trial be ſo certain, as many will be forward to think them. 2. If acidity be gueſſed to be predominant in the ſalt propoſed, it will probably appear by ſuch ways as theſe: by the taſte, odour, or both: by working upon coral or crab's eyes finely powdered: by curdling of milk: by making ſyrup of violets reddiſh: by the power of deſtroying the blue colour of the infuſion of lignum nephriticum: by not being precipitable by potent acid liquors, as oil of vitriol, ſpirit of ſalt; and by being precipitable by oil of tartar *per deliquium*, as alſo by ſtrong ſpirit of urine, and other volatile alcalies, as they are called. But, as I was noting above, I doubt whether theſe proofs be abſolutely certain; for, if I miſtake not, I found ſome purging mineral waters, that would not give even ſo ſlight a proof of acidity, as to deſtroy the blueneſs of the nephritic tincture, which yet would curdle milk, and turn it to a kind of poſſet; and, on the contrary, I found, that ſome German-Spa waters would not curdle milk, and yet would readily deprive the newly mentioned tincture of its ceruleous colour; which yet I did not find, that ſome of our Engliſh ferruginous waters were, at leaſt when brought me to *London*, able to do. 3. The predominancy of an alcali, in the ſalt of a mineral water, may be probably diſcovered by ſuch ways as theſe: by the lixiviate taſte, ſmell, or both; the former of which may be obſerved in the true nitre of the antients, (which I have had brought me from *Ægypt*, and a neighbouring country, whoſe name I do not now remember:) by the turning of ſyrup of violets green: by the precipitation of ſolution of ſublimate made in ſpring-water: by an efferveſcence or conflict with ſome potent acid, as *aqua fortis*, or well dephlegmed ſpirit of ſalt: by heightning the red tincture of logwood or Brazil, drawn with common water; to which may be added a nicer way or two, that I have elſewhere mentioned. But I propoſe theſe ways but as appearing rational, upon the ſcore of my having ſucceſsfully tried them with other ſaline bodies, that were alcaliſate: for as to thoſe mineral waters I have had occaſion to examine, I do not remember I have yet met with any, wherein an alcali was predominant. 4. But, perhaps, farther inquiry will diſcover to others here in *England*, what I have not yet met with; and I doubt not, but that there are, in divers places of the earth, ſalts of an alcaliſate nature. And I preſume, that if the Egyptians were any thing curious of ſuch things, they would find, among their ſprings or wells, divers waters impregnated with them: for I found by trials purpoſely made upon latron, as ſome knowing men call the true Egyptian nitre, preſented me by an inquiſitive ambaſſador, who came out of the Eaſt, that the native ſalt exhibited divers of the ſame phænomena, that other factitious alcalies do. And ſome ſalt, afforded by the famous waters of *Bourbon* in *France*, being brought me thence, with a deſire, that I would examine it, I found it to be evidently alcaliſate; inſomuch that it would make a conflict with acids, and preſently turn ſyrup of violets green. 5. If we ſuſpect vitriol to be much predominant in the ſaline part of a mineral water, we may endeavour to diſcover it by ſuch ways as theſe. By its blackning a ſolution of galls; by its vomitive operation upon the drinkers, though this may ſometimes be an uncertain way, eſpecially becauſe an inviſible permixture of arſenic, or perhaps arſenical fumes, may give the water they impregnate an emetic quality: by putting alcalies to a ſtrong ſolution of the ſuppoſed vitriol, and obſerving, whether it will afford a yellow or yellowiſh precipitate, if ſalt of tartar or ſpirit of urine be dropt into it. By taking notice, whether a ſulphureous ſpirit, eſpecially ſuch an one as I formerly told I had made, though not here deſcribed, will make a blackiſh or a very dark colour with it, as I firſt gueſſed, and then found it would do with ſeveral vitriolate liquors, and even with one, to make which we had diſſolved but one grain of a natural vitriolate ſubſtance in above four or five thouſand times its weight of ſyrup or water. But in the parts about *London* I remember not, that in any of the waters I have made trials on, I have found vitriol to be predominant, or to be ſo much as a manifeſt ingredient; which ſeemed to me the more remarkable, becauſe ſeveral parts about this city are not deſtitute of marcaſites, the parents or wombs of vitriol. Since the writing of theſe papers, being caſually viſited by a diſcerning ſtranger, who had a particular occaſion to take notice of the reſidences of many of the mineral waters of *France*, his native country; he anſwered me, that he never met with any, that was manifeſtly vitriolate; and he ſeemed to be of opinion, that no vitriolate ſpring had yet been diſcovered among the many mineral ones, that are known to be in that country. 7. Since we ſo rarely meet with either manifeſtly acid or evidently alcaliſate ſalts in our Engliſh mineral waters, it may deſerve a ſerious inquiry, what other ſalts they may be impregnated with; and eſpecially from what ſalts the purgative virtue, that is found to belong to many of them, as *Epſom*, *Barnet*, *Acton*, &c. does proceed? Common ſalt indeed, as is already noted, I have found tokens of in the German Spa-water, and in all the Engliſh mineral waters I had occaſion to try, not one that I remember excepted. But I did not find, that common ſalt was ſo copious in any of them, as to diſcloſe itſelf by cryſtallizing in cubical grains. And the way I made uſe of to examine the ſaltneſs of the water without cryſtallization, is not equally certain in all ſorts of them. And becauſe I had not ſtore enough of theſe liquors, to evaporate them in large quantities, though I could not diſcern in the clear ſalts they afforded, either vitriol, or ſalt-petre, or allum, or even common ſalt, by their peculiar and genuine figures; yet I dare not confidently ſay, that none of our Engliſh mineral ſprings abounds with any of thoſe ſalts. But as far as I can gueſs, by the trials, that I have hitherto had opportunity to make, I am apt to think, that the ſalt, that is found in our purgative waters, and in ſome of them copiouſly enough, does not belong to any one known ſort of ſalts, but is either of a ſort, for which, as for many other minerals, we have yet no name; or, which ſeems more probable, is a ſalt of a compounded nature, made up by the coalitions of ſome or all of the ſalts abovementioned, and perhaps of ſome other, as yet nameleſs, ſubterraneal ſalt, that the ſpring inſolves in its paſſage. That two bodies, which are neither of them cathartic, may, by a change of texture wrought in one another, compoſe a third body, that is briſkly purgative, I have ſhewn in another paper. Beſides, having formerly had occaſion, in order to the reſolution of a certain doubt I had entertained, to burn ſalt of tartar with about a double weight of common ſulphur; I thence obtained, as I expected, a neutral ſalt, that had peculiar qualities differing from thoſe of the bodies employed to make it up: and talking of this ſalt with an ingenious empirick, he told me it had a quality I had not mentioned, and that a very uſeful one; ſince in the doſe of half a dram, or in ſome bodies, being taken in wine or broth, it would conſiderably, and yet gently, and without gripings, purge. And without the help of ſalt of tartar I have ſometimes made out of common ſulphur, a chryſtalline ſalt of a ſomewhat vitriolate taſte, the like to which might poſſibly be made under ground, where there are ſubterraneal fires, though perhaps not obſerved nor ſuſpected, ſince we made this ſalt without adding any thing to the ſulphur, only by the help of fire and common water. And I remember, that a great virtuoſo, ſeveral years ago, brought me, in order to an examen he deſired I ſhould make of it, a certain ſalt afforded by a ſpring in or near his land, which I remember was in the weſt of *England*, though I have forgot the name of the county; which ſalt nobody knew what to make of; but I quickly told him I took it to be of the nature of the *ſal mirabile Glauberi*, and predicted, that in ſuch trials it would afford ſuch and ſuch phænomena, which accordingly came to paſs. And I thought, that, if opportunity had not been wanting, this ſalt would have appeared purgative, as ſome factitious ſalts, that reſemble it in tranſparency, colourleſneſs, and figure, have been obſerved to be.

Notes on the twenty-ſeventh title.

1. It is ſurpriſing to obſerve, how great an inequality one may ſometimes meet with in the proportion, that the ſame quantity of two differing mineral waters bear to the *caput mortuum* they reſpectively afford: for a pound, for inſtance, of one may, after evaporation, leave behind it perhaps more drams of dry ſubſtance, than a pound of the other will leave behind it grains. But becauſe I have no notes of the conſiderableſt inſtances of this kind, that came to my knowledge, I ſhall add only by and by the product of a more recent trial. 2. As far as I have hitherto obſerved, thoſe ferruginous waters, that are not heavier than common water, and in moſt drinkers prove but diuretick, afford but very little *caput mortuum*, or dry ſubſtance upon the total evaporation of the liquor; whereas mineral waters, that are purging, and manifeſtly more ponderous in ſpecie than common water, leave, upon evaporation, a conſiderable quantity of reſidence, though ſome far leſs than others. 3. At once to explain, and partly prove, what I have been ſaying, I ſhall here recite, that from a pound of *Barnet* water (which is known to be purgative) ſlowly evaporated, we obtained a dram of white powder: but from the like quantity of *Tunbridge* water, we obtained but about one grain of *caput mortuum*; and, if I miſremember not, we had but about a grain and a half from 25 ounces of the *German* Spa water. 4. It may ſeem ſcarce credible to many, that ſo ſmall a quantity of matter, of which perhaps not one half is ſaline, or metalline, (the reſt being terreſtrial) ſhould impart a manifeſt virtue to ſo great a proportion of water. But this difficulty did not much trouble me, who have purpoſely made divers experiments, to diſcover, how ſmall a proportion of mineral matter may ſuffice, when diſſolved, to impregnate common water. I remember I took one grain of iron ſtone, caſually found near the ſprings at *Iſlington*, (from which mineral it is probable thoſe waters derive their virtue;) this being opened by the fire, and diſſolved as far as it would be in a little ſpirit of ſalt, we let fall a drop or two of the yellowiſh ſolution into a great proportion of infuſion of galls, to which it preſently gave a deeper colour than *Tunbridge* water, or even the *German* Spa water, was wont to give here at *London* with the powder of galls: ſo that we gueſſed, that, if we had then had at hand a competent quantity of the infuſion, the remaining part of the martial ſolution would have been able to colour ten times a greater quantity of the infuſion, than our trial was made upon. This will be eaſily believed by him, that ſhall conſider an experiment we afterwards made to the ſame purpoſe, which was this: we diſſolved a half grain of a good marcaſite, taken up not far from *London*, in a ſmall quantity of ſpirit of nitre, (which for a certain reaſon I made choice of, though other acid menſtruums, as aqua fortis, and ſpirit of ſalt, would have diſſolved the mineral;) this ſmall ſolution we put into a pound of pretty high tincture of galls, made by infuſing them in common water, and finding, as we expected, that this mixture grew very dark, we filled a vial with it, and emptying that vial into a larger glaſs, we filled the ſame vial three times with common water to dilute it; notwithſtanding which, this new mixture, being put into one of our uſual glaſſes, appeared of a colour much deeper than that, which the water of *Tunbridge*, or the *German* Spa, had formerly given with the powder of galls: ſo that probably if another vial of common water had been added, it would yet have afforded a purple colour, if not a deeper; ſo that one part of diſſolved marcaſite communicated a tincture to (61440) ſixty one thouſand four hundred and forty parts of infuſion of galls. And that, which makes this experiment more conſiderable is, that this ſmall quantity of marcaſite was not itſelf all martial or metalline: for from our *Engliſh* marcaſites, as well as others, I have obtained a pretty quantity of ſulphur, like common ſulphur; beſides that they afford a not deſpicable quantity of terreſtrial ſubſtance, about whoſe nature I have not yet ſatisfied myſelf. 5. I ſhall now add this reflection, that ſince the marcaſite impregnated ſo much water with its corporeal parts, if I may ſo call them, obtained by bare diſſolution, it ſeems highly probable, that the ſame quantity of liquor may be impregnated by a far leſs quantity of mineral matter, attenuated into a kind of ſpirituous ſtate by being raiſed in the form of fumes or exhalations; and that imperfect or em-

bryonated iron may be ſo, will ſcarce be denied by them, that conſider the way, that I have, in another paper, delivered to make iron manifeſtly emit copious fumes, without the help of external fire. And if it be with ſome ſuch ſpirituous and volatile exhalations, that a mineral water, as that of *Tunbridge* or of *Iſlington*, is impregnated, it is not hard to conceive, that they may eaſily loſe their chief virtue, by the avolation of moſt or many of their fugitive parts, upon their being removed to a diſtance from the ſpring head. And to make it probable, that vitriolate corpuſcles may be made to aſcend, without loſing their nature, I ſhall here mention an experiment, that I deviſed to give ſome light in this matter. I had often found by trial, that a ſpirit richly impregnated with volatilized ſulphur would with vitriol, whether in the form of a powder or a ſolution, produce in a trice a very dark or blackiſh colour: and gueſſing, that in mercury, turned by the addition of ſalt and vitriol into corroſive ſublimate, many of the vitriolate corpuſcles might aſcend with the mercurial ones, I took ſuch a volatile ſulphureous tincture, as I have been mentioning, (which for this purpoſe ought to be deep) and having dropped it upon good ſublimate, I found it turn preſently of a very opacous colour. To ſhew alſo, that, to make a great dilatation or diſperſion of the martial corpuſcles of an ore or mineral, there needs no ſpirit of ſalt, or the like diſtilled menſtruum, I procured from a copperas-work, (or place where vitriol is made by art) ſome of the liquor they employ before they caſt in iron, that being corroded by it, it may increaſe the weight, and give ſolidity and ſome other qualities to the deſigned vitriol. Now though this liquor be made, without any chymical menſtruum, barely by rain or ſnow-water, that impregnates itſelf with ſaline or metalline particles in its paſſage through beds of marcaſites, that lye expoſed to the ſun and air; yet in this water ſuch numbers of martial corpuſcles are diſperſed, that having ſhaken four drops of it into 12 ounces and a half of common water, this liquor, as I expected, was thereby ſo impregnated, that with powder of galls it preſently produced as deep a colour, as good *Tunbridge* water would have done. So that, ſuppoſing a drop of this liquor to weigh about a grain, (as by ſome trials purpoſely made, we found it to do) it appears, that one part of the vitriolate water was able manifeſtly to impregnate 1500 parts of common water. And yet of theſe four drops or grains of vitriolate liquor a conſiderable part may very probably be concluded, from the way of its production, to have been rain water; as will eaſily be granted, when I ſhall have added, that, to examine this ſuppoſition or conjecture, we ſlowly evaporated ſome ounces of the vitriolate liquor, and found, that the remaining dry ſubſtance did not fully amount to the fourth part of the weight of the whole: at which rate it was eaſy to conclude, that one grain of vitriolate ſubſtance would have been found capable of ſo impregnating ſix thouſand times its weight of common water, as to make it fit to produce, with galls, a purple tincture. We afterwards found, upon trial purpoſely and warily made, that the experiment will hold, though the proportion of the water to the grain of tinging ſubſtance ſhould exceed that lately mentioned, by the weight of ſome hundreds of grains.

TITLES for the natural hiſtory of a mineral water propoſed; conſidered as a medicine, (being the third part of the deſigned work.)

SECT. VI.

THOUGH the effects of a mineral water upon human bodies, as well as upon other ſubjects, may challenge a place in the natural hiſtory of it; yet becauſe the titles of this third part of this ſcheme, for the moſt part, directly regard the cure or prevention of diſeaſes, which are held to be the proper offices of phyſicians as ſuch, I forbore to make any comments upon the particular titles of this part of our hiſtorical idea, contenting myſelf, for the ſake of thoſe, that are ſtrangers to platforms of natural hiſtory, to have ſet down a ſeries of titles, which may point out to them, what particulars may be fit for their inquiry, and furniſh them with heads, whereto they may refer, and receptacles, wherein they may lodge what, upon trials or otherwiſe, they ſhall meet with worthy of obſervation. And ſo the accounts, that ſhall be given on theſe ſubjects, may be ſomewhat more diſtinct, and leſs incomplete.

To what temperaments and conſtitutions the mineral water propoſed is the moſt proper, to what leſs proper, and to what noxious or inconvenient?

IN what ſtated diſeaſes, and in what particular caſes, the mineral water is proper, or to be ſuſpected of being dangerous, if not certainly hurtful?

WHAT difference there is, if any, between the water taken up and preſently drank at the ſpring itſelf, or other receptacle, and that, which is carried to ſome diſtance off, whether in open, or in well ſtopped veſſels?

OF the manifeſt operations of the water in thoſe, that take it, whether it be by vomit, by ſiege, by urine, by ſeveral, or by two, or all of theſe ways.

WHETHER any occult virtues, or other hidden qualities, can be diſcovered in the mineral water? and, if any, what?

WHAT variation in the effects of the mineral water proceeds from its being drank all of it quite cold, or hot, or lukewarm; or one part, when it is in one of thoſe tempers, and the reſt, when in another?

OF promoting or facilitating the operation of the water, in ſome by taking it in bed, and in others by moderate exerciſe.

WHAT aſſiſtance may be given to the operation of the water, by giving with it, eſpecially in the firſt draught, ſomething to make it paſs the better, or to correct its crudity, or to ſtrengthen the ſtomach and bowels?

WHAT advantages may accrue from preparing the patient's body before he enters upon his courſe of drinking the waters? and what inconveniences may attend the neglect of ſuch preparation, eſpecially in groſs, foul, or much obſtructed bodies?

OF the aſſiſtance the water may receive by gently purging medicines, diſcreetly given from time to time.

OF the beſt doſe, or quantity of the water, to be taken at once; of the compaſs of time, wherein it ſhould be all drank; and of the gradual increaſing and leſſening the doſe at the beginning, and ſometimes before the end, of the whole ſpace of time appointed for the taking it.

How much the greater or leſſer length of time ſpent in taking the water conduces to its good effects? and what is the fitteſt meaſure of time to continue the drinking of it, reſpect being had to the patient's ſtrength, diſeaſe, the time of the year, the accidental temperature of the air, and other conſiderable circumſtances?

WHETHER the drinking of the mineral water, for ſeveral years together, be found almoſt neceſſary, or more beneficial, than to intermit it ſometimes for a year or two, or perhaps longer, and then to return to the uſe of it?

OF the diet, as to meat, drink, exerciſe, ſleep, *&c.* that ought to be obſerved by thoſe, that take the water; and of the inconveniences that are wont to follow the neglect of it.

OF the ſigns, that declare the water to work kindly and effectually, and of the tokens of not doing ſo, and thoſe of its being already hurtful or likely to prove ſo.

OF the inconveniences or unwelcome accidents (if there be any, as uſually there is) that have been obſerved to happen, during, or ſome time after, the drinking of the mineral water, eſpecially to perſons of ſuch conſtitutions, or that are in ſuch and ſuch circumſtances, and of the ways to prevent or remedy ſuch inconveniences.

WHETHER there be any neceſſity, or great uſe, of taking phyſick, after one has done drinking the water? and if there be, what are the fitteſt times and medicines to be employed for the prevention of any bad effects of it, and what is the danger of neglect to make uſe of them?

WHETHER, and how, the mineral water may be uſefully given by being ſimply commixed with other liquors or bodies, as by boiling meat in it; or by receiving, together with the additament, a further preparation, as when the water is mingled with wine, or ſome other drink; when with milk it is made into poſſet drink; when brewed with malt alone, or with that and hops, it is turned into ale or beer?

WHETHER any ſuch ſaline, or other ſubſtance may by evaporation, inſpiſſation, calcination, *&c.* be extracted or obtained from the mineral water, as, being given in a ſmall doſe, may be ſubſtituted as a *ſuccedaneum* to large quantities of the water as nature affords it?

OF what uſes (if of any) the mineral water is, when outwardly applied, as by waſhing ſore eyes or ulcers, bathing in it, *&c.* and whether the mud, or ſediment it leaves, where it paſſes or ſtagnates, being externally applied, have the ſame or other medicinal virtues; and, if ſo, how the mud is to be adminiſtred to make it exert them.

OF ſome mechanico-medical trials, that may be made upon animals, to help us to gueſs at the qualities of the mineral waters; as by injecting it into the veins of a dog, to try, whether it will coagulate his blood, or make it more fluid, or operate powerfully by vomit, ſiege or urine; as alſo by keeping a dog very long, without allowing him any other drink at all than the mineral water.

BUT I propoſe ſuch particulars, as are mentioned in this article, but as analogous experiments, or *ſuccedaneums* to trials, that ſhould, but cannot well, becauſe of the worthineſs of the ſubject, be tried in living human bodies. And indeed all the titles of this third part of our deſigned hiſtory belong properly to phyſicians; many of whom (at leaſt if they reſemble you) are far better qualified to cultivate this medicinal ſubject, than I, who being as little deſirous, as fit, to incroach upon their province, ſhall not inlarge upon this third member of our hiſtory, but willingly reſign it into their, and eſpecially into your own more ſkilful hands.

The CONCLUSION.

AND now, Sir, it may be ſeaſonable to put an end, at leaſt for the preſent, to this rhapſody of papers, by telling you, that the foregoing idea, or platform of a hiſtory of mineral waters, being a draught of, or a firſt eſſay upon, ſo difficult and uncultivated a ſubject, as I have ventured to treat of; as I know you are too judicious to expect any thing of exactneſs and compleatneſs, in what I now preſent you, ſo I hope you will be ſo equitable, or ſo favourable, a reader, as to forgive thoſe omiſſions and other imperfections, that I cannot doubt but you, (and even I myſelf upon a review) ſhall diſcover in the firſt edition of the foregoing papers. And though, if hereafter they ſhall be thought worthy of a ſecond, I may poſſibly be able, if GOD will be pleaſed to grant me health and leiſure, to rectify ſome overſights, and ſupply ſome omiſſions; yet, to deal freely with you, I much fear, that it will be very difficult for far ſkilfuller pens, than mine, to deliver ſuch hiſtories of mineral waters, as the curious would wiſh, and thoſe criticks, that have never made trial of the difficulty of attempts of this nature, will be forward to require. And this difficulty will, I preſume, be found a great one, not only, (as I have already noted) by him, that ſhall undertake to give a good account of mineral waters *à priori*, but to him alſo, that ſhall take in all the help he can obtain *à poſteriori*: for there are ſo many circumſtances of ſeaſons, weather, place, and a multitude of contingencies, that may vary the phænomena and effects of mineral waters, that it is extremely difficult, either to comprize ſo many different things at once, and, as it were, ſurvey them at one view, or without having ſuch a comprehenſion and multitude of various regards, to be able to pronounce with certainty about the nature, the medicinal operations, and the other effects of a ſubject, that may be influenced and diverſified by ſo many cauſes and accidents, as a mineral water may. And therefore, 'till further diſquiſitions and trials ſhall have better cleared up the ſubject, I ſhall, without pretending to more, think the paſt diſcourſe not altogether uſeleſs, if it can well perform the office of the *virgula divinatoria*; (which, (ſuppoſing the truth of what many chymiſts and metalliſts deliver,) of how little value ſoever it be of itſelf, is fit to point at mineral treaſures, and ſhew men the places, where they are to ſeek for them. *Farewel*.

This belongeth to the 16th TITLE of the firſt part.

IT is known, that the drinking of ferruginous waters, ſuch as thoſe of the German-Spa and our *Tunbridge*, is uſually preſcribed for many weeks, during which time it often enough happens, that the fall of rains makes men doubt, whether the mineral water be not ſo much diluted, as to be ſpoiled in its medicinal capacity. And indeed I have more than once obſerved, that ſome ſuch martial waters, after conſiderable rains, loſt their power of producing the wonted colour with galls. And therefore it may in ſome caſes be of good uſe to be aſſiſted to conjecture, whether or no the rain have made the mineral water unfit for drinking? In order to this I ſhall take notice, that uſually a ſmall rain does little or no harm to the medicinal ſpring; and ſometimes even a moderate rain, eſpecially after a long drought, may, inſtead of weakning it, increaſe its virtue, by waſhing down into its channel ſome ſalts, that, during the dry weather, were concreted in the pores of the ground, and perhaps alſo by heightning the water in the channel, ſo as to diſſolve ſome ſalts concreted there, which it could not reach before. But if the rain have long continued, the eſtimate may beſt be made, partly by the greater or leſſer depth of the ſpring beneath the ſurface of the ground, and partly, and indeed chiefly, by the peculiar nature or ſtrength of the mineral water; for ſome ſprings are much more copiouſly impregnated than others, and therefore will bear a greater dilution by rain-water, of which I ſhall give you this notable inſtance; that whereas I found (as I lately noted) that more than one of our Engliſh martial ſprings, eſpecially thoſe near *London*, were too much weakned by the water, that rained into them, I had the curioſity to try, how much of that kind of liquor ſome German-Spa-water, that came to me to *London* very well conditioned, would bear; in purſuit of which deſign I warily made ſome trials, which ſhewed, (what probably will be thought ſtrange,) that when the mineral water was diluted with no leſs than thrice its weight of rain-water, it yet retained ſtrength enough to produce with newly powdered galls a purpliſh colour.

AN
ESSAY
OF THE
GREAT EFFECTS
Of even LANGUID and UNHEEDED
MOTION.

Whereunto is annexed,

An EXPERIMENTAL DISCOURSE of ſome little obſerved cauſes of the INSALUBRITY and SALUBRITY of the AIR and its effects. [Being part of an intended NATURAL HISTORY of the AIR.]

ADVERTISEMENT of the PUBLISHER.

IT is thought fit the reader ſhould be informed, that the enſuing tract (about the effects of languid motions) was deſigned to be a part of the author's notes about the origin of occult qualities, and ſhould have come abroad together with the papers about the effluvia of bodies (moſt of which are already publiſhed;) and accordingly it was printed ſeven or eight years ago: which circumſtance is here mentioned, to give a reaſon, why ſeveral particulars were omitted in the body of the diſcourſe, that will be found annexed to the end of it: for theſe occurring to the author, whilſt he curſorily read over the tract itſelf, when it was upon the point to be made publick, it was thought fit rather to ſubjoin them by way of a ſhort appendix, than to let any thing be loſt, that ſeemed pertinent to ſo difficult and uncultivated a ſubject, as that they belong to. The reader is farther to be advertiſed, that of the three preliminary diſcourſes, which the author intended for introductory ones to what he deſigned to ſay more particularly about the mechanical origin or production of occult qualities, one was concerning the relations betwixt the pores of bodies and the figures of corpuſcles: but that the great intricacy and difficulty he found in this copious ſubject made him conſent, that the diſcourſe of local motion, which ſhould have accompanied it to the preſs, ſhould be printed long before it. And thoſe papers about pores and figures having been for a great while out of the author's power, he now to gratify the ſtationer with ſomething, that may, in their ſtead, make up the formerly printed eſſay a book of a convenient bulk, has put into his hands what now comes forth, about ſome unheeded cauſes of the healthfulneſs and inſalubrity of the air; which being chiefly attributed to ſubterraneal ſteams, ſubtile and for the moſt part inviſible, are as near of kin to the other effluviums treated of in the introductory diſcourſe, as is requiſite to keep the mention, that is made of them in this book, from appearing very incongruous.

An ESSAY of the GREAT EFFECTS of even LANGUID and UNHEEDED LOCAL MOTION.

CHAP. I.

HOW ſuperficially ſoever the local motion of bodies is wont to be treated of by the ſchools, who admit of divers other motions, and aſcribe almoſt all ſtrange things in phyſicks to ſubſtantial forms and real qualities; yet it will become us, who endeavour to reſolve the phænomena of nature into matter and local motion, (guided, at the beginning of things, immediately, and ſince regulated, according to ſettled laws, by the great and wiſe author of the univerſe,) to take a heedful notice of its kinds and operations, as the true cauſes of many abſtruſe effects. And though the induſtry of divers late mathematicians and philoſophers have been very laudably and happily exerciſed on the nature and general laws of this motion; yet I look upon the ſubject, in its full extent, to be of ſuch importance, and ſo comprehenſive, that it can never be too much cultivated, and that it compriſes ſome parts, that are yet ſcarce cultivated at all. And therefore I am not ſorry to find myſelf obliged, by the deſign of theſe notes, (written, as you know, to facilitate the explicating of occult qualities) to endeavour to improve ſome neglected corners of this vaſt field, and to conſider, whether, beſides thoſe effects of local motion, which are more conſpicuous, as being produced by the manifeſt ſtriking of one body againſt another, where the bulk, &c. of the agent, together with its celerity, have the chief intereſt; there may not be divers effects, wont to be attributed to occult qualities, that yet are really produced by faint or unheeded local motions of bodies againſt one another, and that oftentimes at a diſtance?

BUT, before I enter upon particulars, this I muſt premiſe in general, (which I have elſewhere had occaſion to note to other purpoſes,) that we are not to look upon the bodies we are converſant with, as ſo many lumps of matter, that differ only in bulk and ſhape, or that act upon one another merely by their own diſtinct and particular powers; but rather as bodies of peculiar and differing internal textures, as well as external figures: on the account of which ſtructures many of them muſt be conſidered as a kind of engines, that are both ſo framed and ſo placed among other bodies, that ſometimes agents, otherwiſe invalid, may have notable operations upon them; becauſe thoſe operations being furthered by the mechaniſm of the body wrought on, and the relation, which other bodies and phyſical cauſes have to it, a great part of the effect is due, not preciſely to the external agent, that it is wont to be aſcribed to, but in great meaſure to the action of one part of the body itſelf (that is wrought on) upon another, and aſſiſted by the concurring action of the neighbouring bodies, and perhaps of ſome of the more catholick agents of nature. This notion or conſideration being in other papers particularly confirmed, I ſhall not now inſiſt upon it, truſting, that you will not forget it, when there ſhall be occaſion to apply it in the following notes.

THERE may be more accounts, than we have yet thought of, upon which local motions may perform conſiderable things, either without being much heeded, or without ſeeming other than faint, at leaſt in relation to the conſiderableneſs of the effects produced by them. And therefore I would not be underſtood in an excluſive ſenſe, when in the following diſcourſe I take notice but of a few of the above-mentioned accounts; theſe ſeeming ſufficient, whereto, as to heads, may be conveniently enough referred the inſtances I allot to this tract.

AND concerning each of theſe accounts, I hold it requiſite to intimate in this place, that I mention it only, as that, whereon ſuch effects of local motion, as I refer to it, do principally depend: for otherwiſe I am ſo far from denying, that I aſſert, that in divers caſes there are more cauſes than one, or perhaps than two of thoſe here treated of apart, that may notably concur to phænomena directly referred to but one or other of them.

TO come then cloſer to our ſubject, I ſhall take notice, that among the ſeveral things, upon whoſe account men are wont to overlook or undervalue the efficacy of local motions, that are either unheeded or thought languid, the chief, or at leaſt thoſe, that ſeem to me fitteſt to be treated of in this paper, are thoſe, that are referrible to the following obſervations.

CHAP. II.

OBSERVATION I.

Men are not uſually aware of the great efficacy of celerity, even in ſmall bodies, and eſpecially if they move but through a ſmall ſpace.

WHAT a rapid motion may enable a body to do, may be judged by the powerful and deſtructive effects of bullets ſhot out of cannons, in compariſon of the battering engines of the ancients, which, though I know not how many times bigger than the bullets of whole cannon, were not able to batter down walls and towers, like bullets, whoſe bulk, compared with theirs, is inconſiderable. Other examples of a like nature might be without impertinency alledged on this occaſion; but becauſe the latter part of our propoſition contains that, which I chiefly aim at, I ſhall proceed to inſtances fit to prove that.

I HAVE ſometimes cauſed a ſkilful turner to turn for me an oblong piece of iron or ſteel, and placing my naked hand at a convenient diſtance to receive the little fragments, perhaps for the moſt part leſſer than ſmall pins heads, as they flew off from the rod, they were, as I expected, ſo intenſely heated by the quick action of the tool upon them, that they ſeemed almoſt like ſo many ſparks of fire; ſo that I could not endure to continue my hand there. And I remember, that once aſking an expert workman, whether he (as I had ſometimes done) did not find a troubleſome heat in the little fragments of braſs, that were thrown off, when that metal was turning? he told me, that heat was ſometimes very offenſive to his eyes and eye-lids. And when I aſked, whether it was not rather as duſt caſt into them, than from their heat? he replied, that, beſides the ſtroke, he could ſenſibly feel a troubleſome heat, which would make even his eye-lids ſore: and that ſometimes, when he employed a rough tool, that took off ſomewhat greater chips, he had found the heat ſo vehement, that not only it would ſcorch his tender eye-lids, but the thick and hard ſkin of his hands; for proof whereof, he ſhewed me in one of his hands a little bliſter, that had been ſo raiſed, and was not yet quite gone off.

AND inquiring about theſe matters of a famous artiſt employed about the finiſhing up of caſt ordnance, he confeſſed to me, that, when with a ſtrong as well as peculiar engine he and his aſſociates turned great guns very ſwiftly, to bring the ſurface to a competent ſmoothneſs, the tools would ſometimes throw off bits of metal of a conſiderable bigneſs, which, by reaſon of their bulk and their rapid motion, would be ſo heated, as to burn the fingers of the country-people, that came to gaze on his work, when he, for merriment ſake, deſired them to take up ſome of thoſe pieces of metal from the ground: which I thought the more remarkable, becauſe, by the contact and coldneſs of the ground, I could not but ſuppoſe their heat to have been much allayed; not to mention, that I learnt from an experienced artificer, that in turning of braſs the little fragments of that metal acquire an intenſer heat, than thoſe of iron.

I REMEMBER alſo, that to vary the experiment mentioned juſt before this laſt, by making it with a body far leſs ſolid and heavy, than braſs or iron, I cauſed an artificer to turn very nimbly a piece of ordinary wood, and holding my hand not far off, the powder, that flew about upon the operation, ſtruck my hand in many places with that briſkneſs, that I could but uneaſily endure the heat, which they produced where they hit; which heat, whether it were communicated from the little, but much heated, fragments to my hands, or produced there by the briſk percuſſion on my hand, or were the joint effect of both thoſe cauſes, it will however be a good inſtance of the power of celerity even in very ſmall bodies, and that move but a very little way.

IT is conſiderable to our preſent purpoſe, that by an almoſt momentany percuſſion, and that made with no great force, the parts, even of a vegetable, may be not only intenſely heated, but brought to an actual ignition; as we have ſeveral times tried, by ſtriking a good cane (of that ſort, which is fit for ſuch experiments) with a ſteel, or even with the back of a knife; for, upon this colliſion, it would ſend forth ſparks of fire like a flint.

TO the ſame purpoſe may be alledged, that, by but dextrouſly ſcraping good loaf-ſugar with a knife, there will be made ſo briſk an agitation of the parts, that ſtore of ſparks will be produced. But that is more conſiderable, which happens upon the colliſion of a flint and a ſteel: for though vitrification be by chymiſts eſteemed the ultimate action of the fire; and though, to turn ſand or ſtones, though very finely powdered, into glaſs, it is uſually required, that it be kept for divers hours in the intenſe fire of a glaſs-houſe; and though, laſtly, the glaſs-men complain, that they cannot bring flints or ſand to fuſion without the help of a good proportion of Borillia or ſome other fixed ſalt; yet both actual ignition and vitrification are brought to paſs almoſt in a moment by the bare vehemence of that motion, that is excited in the parts of a flint, when it is ſtruck with a ſteel: for thoſe ſparks, that then fly out, (as an ingenious perſon has obſerved, and as I have often ſeen with a good microſcope,) are uſually real and permanent parcels (for the moſt part globulous) of ſtone vitrified and ignited by the vehemence of the motion. And that this vitrification may be of the ſtone itſelf, though ſteel be a metal of a far more fuſible nature than a flint, I am induced to think, becauſe I have tried, that not only flints with ſteel, but flints with flints, and more eaſily pieces of rock-cryſtal between themſelves, will by colliſion ſtrike fire. And the like effect of colliſion I have found myſelf in ſome precious ſtones, harder than cryſtal. And afterwards inquiring of an ingenious artificer, that cuts diamonds, whether he had obſerved the like, when diamonds were grated on by the rapid motion of his mill? he replied, that he obſerved diamonds to ſtrike fire almoſt like flints; which afterwards was confirmed to me by another experienced cutter of gems: and yet having made divers trials on diamonds with fire, he would not allow, that fire itſelf can bring them to fuſion.

The cauſe of a flint's ſparkling. Mr. *Hooke*.

Nor are fluid bodies, though but of ſmall dimenſions, to be altogether excluded from the power of making conſiderable impreſſions on ſolid bodies, if their celerity be great.

Whether the ſun-beams conſiſt, according to the atomical doctrine, of very minute corpuſcles, that, continually iſſuing out of the body of the ſun, ſwiftly thruſt on one another in phyſically-ſtraight lines; or whether, as the Carteſians would have it, thoſe beams be made by the briſk action of the luminary upon the contiguous fluid, and propagated every way in ſtraight lines through ſome æthereal matter harboured in the pores of the air; it will be agreeable to either hypotheſis, that the ſun-beams, refracted or reflected by a burning-glaſs to a focus, do there, by their concourſe, compoſe a ſmall portion of fluid matter; and yet the celerity, wherewith the ſoft and yielding ſubſtance is agitated, enables ſo few of them, as can be circumſcribed by a circle not a quarter of an inch in diameter, to ſet afire green wood in leſs than a minute, and (perhaps in as little time as that) to melt not only tin and lead thinly beaten, but, as I have tried, foliated ſilver and gold.

The operation of ſmall portions of fluid matter on ſolid bodies will be farther exemplified in the fourth chapter, by the effects of the blown flame of a lamp on glaſs and metals; ſo that I ſhall here need but to point in general at the wonderful effects, that lightning has produced, as well by the celerity of its motion, as by the matter, whereof it conſiſts: of which effects hiſtories and the writings of meteorologiſts afford good ſtore; and I have been an admiring obſerver of ſome of them, one of the laſt of which was, the melting of metal by the flame in its paſſage, which probably laſted but the twinkling of an eye.

A wind-gun.

And even a ſmall parcel of air, if put into a ſufficiently-briſk motion, may communicate a conſiderable motion to a ſolid body; whereof a notable inſtance (which depends chiefly upon the celerity of the ſpringy corpuſcles of the air) is afforded by the violent motion communicated to a bullet ſhot out of a good wind-gun. For when this inſtrument is well charged, the ſtrongly-compreſt air being ſet at liberty, and forcibly endeavouring to expand itſelf to its wonted laxity, its corpuſcles give a multitude of impulſes to the bullet all the while, that it continues moving along the barrel, and by this means put it into ſo rapid a motion, that I found, by trial, the bullet would, in a moment, be flatted almoſt into the figure of an hemiſphere, by being ſhot off againſt a metalline plate.

And farther to ſhew, how ſwift that motion muſt have been, and with what celerity a vehement agitation may be communicated to the parts of a ſolid body, I ſhall add here, (though the phænomenon might be referred to the fifth chapter,) that, though the contact of the bullet and the metalline plate laſted probably but a phyſical moment; yet the minute parts of the bullet were put into ſo various and briſk an agitation, that making haſte to take it up before it ſhould cool, I found it too hot to be, with overmuch eaſe, held between my fingers.

CHAP. III.

Observation II.

We are too apt to think, that fluid bodies, becauſe of their ſoftneſs, cannot have by their bare motion, eſpecially if inſenſible, any ſenſible effect upon ſolid ones; though the fluid moves and acts as an intire body.

It is not my purpoſe here to inſiſt on the efficacy of the motion of ſuch fluid bodies, as may have their motions diſcovered by the eye like ſtreaming water, or manifeſtly perceived by the touch, as are the winds, that beat upon us; ſince it were needleſs to give inſtances of ſuch obvious things, as the great effects of overflowing waters and violent winds; the latter of which, notwithſtanding the great tenuity and ſoftneſs of the air, and the effluvia, that ſwim in it, have been ſometimes able to blow down, not only timber-trees, but houſes and ſteeples, and other the firmeſt ſtructures. But the motions, I intend to ſpeak of in this chapter, are ſuch, as we do not immediately either ſee or feel; and though theſe be exceeding rare, yet the operation of ſounds, even upon ſolid bodies, and that at a diſtance from the ſonorous ones, afford me ſome inſtances to my preſent purpoſe, which I ſhall now proceed to mention.

It has been frequently obſerved, that, upon the diſcharge of ordnance and other great guns, not only the ſound may be diſtinctly heard a great way off; but that, to a good diſtance, the tremulous motion of the air, that produces ſound, without producing any ſenſible wind, has been able ſenſibly to ſhake, and ſometimes violently to break, the glaſs-windows of houſes and other buildings, eſpecially when the windows ſtand in the way, wherein the propagation of the ſound is directly made. It is true, that theſe obſervations are moſt frequent, when the place, where the artillery is placed, ſtands upon the ſame piece of ground with the houſes, whoſe windows are ſhaken; and ſo it may be ſuſpected, that the ſhake is firſt communicated by the cannon to the earth or floor, on which they play, and is afterwards by that propagated through the intermediate parts of the ground to the foundations of the houſes, and ſo to the windows. And I readily grant, and may elſewhere ſhew, that a violent impulſe upon the ground may reach to a greater diſtance, than men uſually imagine: but in our preſent caſe I ſee no neceſſity of having recourſe to any thing but the wave-like motion of the air for the production of our phænomenon, ſince the like may be produced by local motion tranſmitted by fluids, as may appear by the following inſtances.

I was once invited by an engineer to ſee trial made of a ſtrange inſtrument he had to ſink ſhips, though great ones, in a few minutes; and though an unlucky accident kept me from arriving there, until near a quarter of an hour after the trial had been made on an old frigate with better ſucceſs, than my philanthropy allowed me to wiſh; yet cauſing myſelf to be rowed to the place, where the great veſſel was newly ſunk, the oddneſs of the effect, which was performed upon the water by a ſmall inſtrument outwardly applied, made me inquiſitive, what noiſe and commotion had been made; and I was informed, partly by the engineer himſelf, and partly by ſome acquaintances of mine, who among a great number of ſpectators ſtood aloof off, in ſhips and other veſſels lying at anchor, to ſee the event, that, upon the engineer's operating, the exploſion was ſo great, that it made a kind of ſtorm in the water round about, and did ſo rudely ſhake veſſels, that lay at no inconſiderable diſtance, as to make thoſe, that ſtood on them, to ſtagger.

In the late great ſea-fight between the Engliſh fleet, commanded by his royal highneſs the duke of *York*, and the dutch admiral *Opdam*, (who therein loſt the victory and his life,) though the engagement were made very many leagues from the *Hague*, yet the noiſe of the guns not only reached to that place, but had a notable effect there; of which when I inquired of the Engliſh embaſſador, that as yet reſided there, he was pleaſed to aſſure me, that it ſhook the windows of his houſe ſo violently, that, not knowing what the cauſe was, he was ſurprized and much alarmed, apprehending, that ſome rude fellows were about to break his windows to affront him. And if there be a greater diſpoſition in ſome other bodies, than there is in glaſs-windows, to receive ſtrong impulſes from the air agitated by ſounds, theſe may be ſenſibly, though not viſibly, wrought upon, and that at a good diſtance, by the noiſe of a ſingle piece of ordnance; as may appear by that memorable circumſtance of an odd caſe about a gangrene mentioned by the experienced *Simon Pauli* in his ingenious tract *de Febribus malignis*, pag. 71. *Atqui æger ille Gallus brachio truncatus octiduum quidem ſuperfuit, ſed horrendis totius corporis convulſionibus correptus; qui quoque, (ut & illa addam obſervatione digniſſima,) dum in domini ſui ædibus ad plateam Kiodmoggerianam, Romane* Laniorum *appellares, decumberet, ac, me ac aliis aliquandiu ad lectum illius conſidentibus quidem, ſed nobis non attendentibus, exploderentur tormenta bellica ex Regiis ac Prætoriis navibus, ſiniſtrâ truncum dextri brachii fovens ac complectens, toties quoties exploderentur ſingula exclamabat, Au, au, me miſerum! Jeſu, Maria, contundor penitùs: adeò permoleſta & intolerabilis illi erat tormentorum exploſio, & quidem ex loco ſatis longinquo, terrâ non firmâ aut contiguâ, verùm ſuper ſalo aut mari Balthico inſtituta.* “*Simon Pauli*, in his ingenious treatiſe of peſtilential fevers, *p.* 71. tells us of a ſick *Frenchman*, who lived ſeveral days after his arm was cut off, though he was all the while moſt cruelly tortured by not ordinary convulſion fits: but what is moſt obſervable is this, that I and others ſitting one day by his bed-ſide, but not taking notice, that the great guns were going off from the king's ſhips, he laying hold and cheriſhing the ſtump of his right arm, broke out at every ſhot into theſe pitiful words; *Jeſus, Maria,* What do I not ſuffer! I am quite bruiſed: ſo troubleſome, and inſufferable to him was the ſhooting of the great guns, though at a great diſtance, they being fired not in a joining continent, but on the *Baltick-Sea.*” By this it appears, that the guns, whoſe diſcharge produced theſe painful motions in the patient, reſted upon a floating body. And I remember, that an illuſtrious commander of a very great man of war being aſked by me, whether of the many wounded men he had in his ſhip in a very long ſea-fight, none of them were affected by that noiſe of the enemy's cannon diſcharged in ſhips at a diſtance? he anſwered me, that ſome, whoſe bones were broken, would ſadly complain of the torment they were put into by the ſhake they felt at the going off of the enemy's cannon, though they were too much accuſtomed to the report of great guns, to be, as it was a bare noiſe, offended by it. If, after all this it be ſurmized, that theſe motions were not conveyed by the air, but propagated by the water, (and, in ſome caſes, ſome part of the ſhore) from the ſhips, where the guns were fired, to the houſes, where the windows were ſhaken, or the places, where the wounded men lay; I anſwer, that if this could be made probable, it would accommodate me with very eminent inſtances for the chapter of the propagable nature of motion; and though it be very difficult to find ſuch examples of ſhakes excited by ſounds, as are not liable to the mentioned objection, becauſe the ſonorous bodies here below do all either ſtrike, or lean, upon ſuch groſs and viſible bodies, as the earth and water; yet there is one kind of ſound, that muſt be confeſſed to be propagated by the air, as being made in it; and that is thunder, whoſe noiſe does ſometimes ſo vehemently affect the air, tho' without producing any ſenſible wind, that both others and I have obſerved it very ſenſibly to ſhake great and ſtrong houſes, notwithſtanding the diſtance of the clouds, where the noiſes were firſt produced. And I remember, that having inquired of ſome ſea-captains, that in ſtout veſſels ſailed to the *Indies*, whether they had not in thoſe hot regions obſerved their ſhips, though very much leſs tall than houſes, to be ſhaken by vehement thunders? I perceived, that ſome of them had not much heeded any ſuch thing; but a couple of others told me they had obſerved it in their ſhips; and one of them told me, that once, when the claps of thunder were extraordinary great, ſome of them ſhook his ſhip ſo rudely, as to make the unwonted motions diſorder his great guns. All which I the leſs wonder at, when calling to mind, what I have mentioned in the foregoing chapter and elſewhere of the power of the celerity of motion, I conſider, that there is no celerity, that we know of here below, that is near ſo great, as that, wherewith a ſound is propagated through the air. For, whereas the diligent *Merſennus* obſerves, that a bullet ſhot out of a cannon or a muſket does not overpaſs two hundred and forty yards in a ſecond, or ſixtieth part of a minute; I have more than once diligently obſerved, that the motion of ſound paſſes above four hundred yards in the ſame time of a ſecond here in *England*; which I therefore add, becauſe *Merſennus* relates, that in *France* he obſerved a ſound to move in that time many yards more; which may poſſibly proceed from the differing conſiſtence of the Engliſh air and the French.

The great loudneſs of theſe ſounds, and the vehement percuſſion, that the air receives in their formation, will probably make it be eaſily granted, that it was only the impetuoſity of the motion of the *Medium*, that gave the ſhake to the windows and other ſolid bodies, that I have been mentioning to have been made to tremble by the report of cannon or thunder. But yet I will not on this occaſion conceal, that perhaps it may without abſurdity be ſuſpected, that ſome of thoſe tremulous motions of ſolid bodies might either depend upon, or at leaſt be promoted by, ſome peculiar diſpoſition, that glaſs (which is endued with ſpringineſs,) and ſome other bodies, that perhaps are not quite devoid of that quality, may have to be moved by certain congruous ſounds (if I may ſo call them) more than they would by others, though perchance more loud: but though this ſurmize ſhould be admitted, yet it would not render the lately recited inſtances improper for the deſign of this diſcourſe, but only would make ſome of them fit to be referred to another chapter; to which I ſhall advance, as ſoon as I ſhall have annexed an odd obſervation of the experienced *Platerus*, which argues, that where there is a peculiar diſpoſition, even in a firm body, it may receive conſiderable impreſſions from ſo languid a motion (though in likelihood not peculiarly modified) of the air, as is not ſenſible to other bodies of the ſame kind.

Fœmina quædam (ſays he) *in ſubitaneum incidit morbum, viribus ſubitò proſtratis, ſe ſuffocari indeſinenter clamitans, etſi nec ſtertoris nec tuſſis aliqua eſſent indicia; maximè verò de aura quadam adveniente, ſi vel leviter aliquis adſtantium ſe moveret, quæ illam opprimeret, conquerebatur, ſeque ſuffocari, ſi quis propiùs accederet, clamitabat: vixdum biduum in ea anxietate perſeverans, expiravit.* To which he adds: *Vidi & alios ægros, de ſimili aura, quæ eos, ſi quis illis appropinquaret, in ſuffocationis periculum induceret, conquerentes; quod ſemper peſſimum eſſe ſignum deprehendi.* “*Platerus* in the firſt book of his obſervations, *p.* 185. gives us this following account, *p.* 26. A woman being fallen ſick on a ſudden, complained continually of her being ſtrangled, though there was no great appearance thereof; this ſhe aſcribed chiefly to a certain air or wind, which ſhe was ſo ſenſible of, that if any body happened to come near her, ſhe would immediately complain of her being choaked, and died the ſecond day of this odd diſtemper. To which he adds, I have known ſeveral others complain of a not unlike wind, and that they were in danger of being choaked, if any body came near them; which I conceived always to be a very ill ſign.”

CHAP. IV.

Observation III.

Men undervalue the motions of bodies too ſmall to be viſible or ſenſible, notwithſtanding their numerouſneſs, which enables them to act in ſwarms.

Most men, when they think at all of the effluvia of bodies and their motions, are wont to think of them, as if they were but much finer ſorts of duſt, (whoſe grains, by reaſon of their ſmallneſs, are inviſible,) which, by the various agitation of the air, are, as it were, by ſome faint wind blown againſt the ſurfaces of the bodies they chance to meet in their way, and that they are ſtopped in their progreſs without penetrating into the interior parts of the bodies they invade. And, according to this notion, it is no wonder, that men ſhould not fancy, that ſuch minute bodies paſſing, as they ſuppoſe, no further than the ſurfaces of thoſe, on which they operate, ſhould have faint operations upon them.

But we may have other thoughts, if we well conſider, that the corpuſcles we ſpeak of, are, by their minuteneſs, aſſiſted, and oftentimes by their figure enabled, to pierce into the innermoſt receſſes of the body they invade, and diſtribute themſelves to all, or at leaſt to multitudes of the minute parts, whereof that body conſiſts. For this being granted, though we ſuppoſe each ſingle effluvium or particle to be very minute; yet, ſince we may ſuppoſe even ſolid bodies to be made up of particles, that are ſo too, and the number of invading particles to be not ſo much inferior to that of the invaded ones, or at leaſt to be exceedingly great, it need not ſeem incredible, that a multitude of little corpuſcles in motion (whoſe motion, may, for aught we know, be very ſwift) ſhould be able to have a conſiderable operation upon particles either quieſcent, or that have a motion too ſlow to be perceptible by ſenſe: which may perhaps be the better conceived by the help of this groſs example:

If you turn an ant-hill, well ſtocked with ants-eggs, upſide down, you may ſometimes ſee ſuch a heap of eggs mingled with the looſe earth, as a few of thoſe inſects, if they were yoked together, would not be able at once to draw after them; but if good numbers of them diſperſe themſelves and range up and down, and each lay hold of her own egg, and hurry it away, it is ſomewhat ſurpriſing to ſee (as I have with pleaſure done) how quickly the heap of eggs will be diſplaced, when almoſt every little egg has one of thoſe little inſects to deal with it.

AND in thoſe caſes, wherein the invading fluid does not quite disjoin and carry off any great number of the parts of the body it invades, its operation may be illuſtrated by that of the wind upon a tree in autumn: for it finds or makes itſelf multitudes of paſſages, for the moſt part crooked, not only between the branches and twigs, but the leaves and fruits; and in its paſſing from the one ſide to the other of the tree, it does not only variouſly bend the more flexible boughs and twigs, and perhaps make them grate upon one another, but it breaks off ſome of the ſtalks of the fruit, and makes them fall to the ground, and withal carries off divers of the leaves, that grew the leaſt firmly on, and in its paſſage does, by its differing parts, act upon a multitude of leaves all at once, and variouſly alters their ſituation.

BUT to come to cloſer inſtances: ſuppoſe we caſt two lumps, the one of ſugar, the other of amber, into a glaſs of beer or water, they will both fall preſently to the bottom. And though perhaps the amber may be lighter than the ſugar, (for, I have found a notable difference in the ſpecific gravity of pieces of amber,) yet the aqueous particles are far from being able to diſplace the amber or any ſenſible part of it, or exerciſe any viſible operation upon it: but the ſame minute particles of the liquor being of a figure, that fits them to inſinuate themſelves every way into the pores of the ſugar, though the lump conſiſted of very numerous ſaccharine corpuſcles, yet the multitude of the aqueous particles, to which they are acceſſible, is able in no long time to diſperſe them all, and, carrying them along with themſelves, make the whole lump of ſugar in a ſhort time quite diſappear.

THE point above diſcourſed of may be more nimbly exemplified in ſome chymical operations, and particularly in this. If, by a due degree of fire, you abſtract from running mercury four or five times its weight of good oil of vitriol, there will remain at the bottom a dry and brittle ſubſtance exceeding white; and if upon this heap of mercurial and ſaline bodies, which ſometimes may be coherent enough, you pour a good quantity of limpid water, and ſhake them together, you may ſee in a trice the multitude of little white grains, that make up the maſs, pervaded and manifeſtly altered by the diſperſed corpuſcles of the water; as will plainly appear by the change of the calx or precipitate from a white maſs into one of a fine lemon colour.

BUT, to give inſtances in fluid bodies, (which I ſuppoſe you will think far the more difficult part of my taſk,) though you will eaſily grant, that the flame of ſpirit of wine, that will burn all away, is but a viſible aggregate of ſuch effluvia ſwiftly agitated, as without any ſenſible heat would of themſelves inviſibly exhale away; yet, if you be pleaſed to hold the blade of a knife, or a thin plate of copper, but for a very few minutes, in the flame of pure ſpirit of wine, you will quickly be able to diſcern by the great heat, that is, the various and vehement agitation of the minute corpuſcles of the metal, what a number of them muſt have been fiercely agitated by the pervaſion of the igneous particles, if we ſuppoſe, (what is highly probable,) that they did materially penetrate into the innermoſt parts of the metal; and whether we ſuppoſe this or no, it will, by our experiment, appear, that ſo fluid and yielding a body, as the flame of ſpirit of wine, is able, almoſt in a trice, to act very powerfully upon the hardeſt metals.

THE power of extremely minute parts of a fluid body, even when but in a moderate number they are determined to conſpire to the ſame operation, may be eſtimated by the motions of animals, eſpecially of the larger and more bulky ſorts, as horſes, bulls, rhinoceroſes and elephants. For though the animal ſpirits be minute enough to be inviſible, and to flow through ſuch tender paſſages, that prying anatomiſts have not been able in diſſected nerves to diſcern ſo much as the channels, through which they paſs; yet thoſe inviſible ſpirits, conveyed (or impelled) from the brain to the nerves, ſerve to move in various manners the limbs, and even the unweildy bodies themſelves of the greateſt animals, and to carry them on in a progreſſive motion for many hours together, and perhaps enable them to ſpring into the air, and move through it by leaping; though divers of theſe animals weigh many hundred, and others ſeveral thouſand of pounds.

I WILL not here conſider, whether the following experiment may at all illuſtrate motions, that are produced by the fluid parts of animals in ſome of the conſiſtent ones: but I preſume it may confirm the obſervation maintained in this chapter, if I add, what I have tried of the conſiderable force of a number of aqueous particles, as flexible and as languid as they are thought to be, inſinuating themſelves into the pores or intervals of a rope, that was not thick. For in moiſt weather I ſometimes obſerved, that the aqueous and other humid particles ſwimming in the air, entering the pores of the hemp in great numbers, were able to make it ſhrink, though a weight of fifty, ſixty, or even more pounds of lead were tied at the end to hinder its contraction, as appeared by the weight's viſibly being raiſed in wet weather above the place it reſted at in dry.

BUT to return to what I was formerly ſpeaking of the determination of the motion of fluids; I ſhall on this occaſion obſerve, that though the wind or breath, that is blown out at a ſmall crooked pipe of metal or glaſs, ſuch as tradeſmen for its uſe call a blow-pipe, ſeems not to have any great celerity, eſpecially in compariſon of that of the parts of flame, and is itſelf of little force; yet, when by this wind the flame of a lamp or candle is directed ſo, as to beat with its point upon a body held at a convenient diſtance from the ſide of the flame, the burning fluid, determined, and perhaps excited by this wind, acquires ſo great a force, that, as we have often tried, it may be made in a few minutes to melt not only the more fuſible metals, but ſilver, or even copper itſelf; which yet may be kept for many hours unmelted in a crucible kept red-hot, or even in the flame of the lamp or candle unaſſiſted by the blaſt.

And if we can ſo contrive it, that a flame does not come to invade only the ſurface, that inveſts a body, but comes to be intermingled with the ſmaller (though not the ſmalleſt) parts it conſiſts of, as with its filings or its powder; the flame will then have a far more quick and powerful operation than the body expoſed to it. This I exemplify (in other papers,) and in this place it may ſuffice to obſerve, that, whereas a pound or two of tartar may coſt you ſome hours to calcine it to whiteneſs, if the flame have immediate acceſs only to the outward parts; you may calcine it in a very ſmall part of that time, if, mixing with its groſs powder an equal weight of good ſalt-petre, you fire the mixture, and keep it ſtirring, that the parts of the kindled nitre may have acceſs at once to very many parts of the tartar, and have opportunity to calcine them. And by ſomewhat a like artifice I elſewhere teach, how nitre itſelf may without tartar be ſpeedily reduced to a calcinatum not unlike that newly mentioned. But it may be ſaid, that ſome of the foregoing inſtances (for it cannot be truly ſaid of all) may indeed illuſtrate what we are diſcourſing of, but will not reach home to our purpoſe.

I shall therefore conſider the load-ſtone, which you acknowledge to act by the emiſſion of inſenſible particles. For though iron and ſteel be ſolid and ponderous bodies, and magnetical effluvia be corpuſcles ſo very minute, that they readily get in at the pores of all kinds of bodies, and even of glaſs itſelf; yet theſe magnetical effluvia entering the ſteel in ſwarms, do in a trice pervade it, and a multitude even of them acting upon the corpuſcles of the metal do operate ſo violently on them, that if the load-ſtone be vigorous enough, and well capped, it will attract a notable proportion of ſteel, and ſurmount the gravity of that ſolid metal, which I have found to exceed, when the ſtone has been very good and little, above fifty times the weight of the magnet, by whoſe effluvia it was ſupported: for to theſe I rather aſcribe magnetical attraction and ſuſtentation, than to the impulſe or preſſure of the ambient air, to which many corpuſcularians have recourſe; becauſe I have found by trial (which I elſewhere relate) that the preſſure of the ambient air is not abſolutely neceſſary to magnetical operations.

I remember, that to help ſome friends to conceive, how ſuch extremely-minute particles, as magnetical effluvia, may, by pervading a hard and ſolid body, ſuch as iron, put its inſenſible corpuſcles into motion, and thereby range them in a new manner, I took filings of ſteel or iron freſhly made, that the magnetical virtue might not be diminiſhed by any ruſt; and having laid them in a little heap upon a piece of paper held level, I applied to the lower ſide of the paper, juſt beneath the heap, the pole of a vigorous load-ſtone, whoſe emiſſions traverſing the paper, and diffuſing themſelves through the incumbent metal, did in a trice manifeſtly alter the appearance of the heap; and though each of the filings might probably contain a multitude of ſuch martial corpuſcles, as ſteel may be divided into by oil of vitriol or ſpirit of ſalt, yet the magnetical effluvia immediately pervading our metalline heap did ſo remove a good part of the filings, that compoſed it, as to produce many erected aggregates, each of which conſiſted of ſeveral filings placed one above another, and appearing like little needles, or rather like the ends of needles broken off at ſome diſtance from the point: and as theſe little temporary needles ſtood all of them erected (though more or leſs, according to their diſtance from the pole of the magnet) upon the flat paper; ſo they would, without loſing their figure or connexion, be made, as it were, to run to and fro upon the paper, according as the load-ſtone, that was held underneath it, was moved this way and that way; and as ſoon as that was taken quite away, all this little ſtand of pikes (if I may ſo call it) would (almoſt in the twinkling of an eye) relapſe into a confuſed heap of filings.

Opinions of freezing

There are two ways of explicating the turning of water into ice; one or other of which is approved almoſt by all the corpuſcularian philoſophers. The firſt is that of the Carteſians, who give an account of glaciation by the receſs of the leſs ſubtile particles of the ethereal matter, without which the finer parts were too ſmall and feeble to keep the eel-like particles of water flexible, and in the form of a liquor. The atomiſts on the other ſide aſcribe the freezing of water to the ingreſs of multitudes of frigorific corpuſcles, as they call them, which, entering the water in ſwarms, and diſperſing themſelves through it, crowd into the pores, and hinder the wonted motion of its parts, wedging themſelves (if I may ſo ſpeak) together with them into a compact body. But which ſoever of theſe two hypotheſes be pitched upon, the phænomenon itſelf will afford me a notable inſtance to my preſent purpoſe. For the particles of water, and much more the corpuſcles of cold, are confeſſed to be ſingly too ſmall to be viſible, and their motions are not ſaid to be ſwift, but may rather be judged to be ſlow enough; and yet thoſe minute aqueous, or more minute frigorific particles, becauſe of their number, produce in the glaciation of the liquor ſo forcible a motion outwards, as to make it break bottles, not only of glaſs and earth ſtrongly baked, but, as I have ſeveral times tried, of metal itſelf, that, being full of the liquor, were firmly ſtopped before the ſupervening of the cold. And the expanſive endeavour of freezing water is not only capable of doing this, but of performing ſo much greater things, which I elſewhere relate, that my trials have made me ſometimes doubt, whether we know any thing in nature, except kindled gunpowder, that bulk for bulk moves more forcibly, though the motion ſeems to be very ſlow.

CHAP. V.

(Of the propagable nature of motion.)

OBSERVATION IV.

Men are not ſufficiently aware, how propagable local motion is, even through differing mediums and ſolid bodies.

THERE are four principal occaſions, on which I have obſerved, that men are wont to think the communicating of motion much more difficult, than indeed it is.

AND firſt, there are many, that obſerving how uſually thoſe bodies, that hit againſt hard ones, rebound from them, eaſily perſuade themſelves, that motion can ſcarce be tranſmitted or diffuſed through ſolid bodies. But, though it be true, that oftentimes in ſuch caſes the progreſſive motion of the body or the ſolid, that is ſtruck or impelled, be either inconſiderable, or perhaps not ſo much as ſenſible; yet the impulſe may make a conſiderable impreſſion, and may be communicated to a great ſhare of the particles of that matter, whereof the ſolid maſs conſiſts; as we ſee in the ſtriking of a timber-beam at one end, the motion, though perhaps it were not ſtrong at the firſt, may become ſenſible at the other. Though bell-metal be ſo hard a body, that it is reckoned harder than iron itſelf, inſomuch that oftentimes it reſiſts even files of ſteel, which readily work on iron; yet this ſolidity hinders not, but that, as I have found, conveniently ſhaped veſſels of bell-metal, though thick, will be ſenſibly affected by a motion, that neither is ſtrong, nor touches them in more than a ſhort line, or perhaps than a phyſical point. The truth of this I have found by trial on more than one ſuch veſſels, and particularly on one, that was hemiſpherical, which being placed or held in a convenient poſture, if I did but gently paſs the point of a pin for a little way along the brim of it, it would ſenſibly reſound, and that (to a very attentive ear) ſo long, and in ſuch a ringing manner, as made it highly probable, that the parts immediately touched (and not ſo much as ſcratched) by the point of a pin, were not only put into a vibrating motion themſelves, but were enabled to communicate it to thoſe, that were next them, and they to thoſe, that were contiguous to them; and ſo the tremulous motion was propagated quite round the bell, and made divers ſucceſſive circulations before it quite ceaſed to be audible. And if inſtead of drawing a line on the brim of the veſſel, I ſtruck it, though but faintly, with the point of a pin, though the part immediately touched would be but a phyſical point, yet the motion would be, like the former, propagated ſeveral times quite round; as was argued by the ringing and duration of the produced ſound, though this metalline veſſel were ſeven inches in diameter, and of a conſiderable thickneſs. Nor was a ſolidity like that of braſs requiſite to produce theſe effects; for I found them to inſue much after the ſame manner, when I employed only a ſhort and ſlender thread of glaſs, which, though little, if at all, thicker than a pin, was yet hollow quite through. Now, if it be true, as it is highly probable, that ſound, as it belongs to the air, conſiſts in an undulating motion of the air, and ſo in our caſe requires a vibrating motion in the ſonorous body to impart that motion to the air; we muſt grant in our inſtances a wonderful propagableneſs of motion, even when it is not violent, in ſolid bodies themſelves; ſince the point of a pin, gently ſtriking a part, no bigger than itſelf, of a maſs of very ſolid metal, could thereby communicate a ſenſible motion, and that ſeveral times circulated, to millions of parts equal to it in bulk, and much exceeding it in hardneſs. And ſince the effect was more conſiderable, when the trial was made in a much greater, than in a ſmaller veſſel; it is probable, that, if I had had the opportunity of experimenting on a large and well-hung bell, the phænomenon would have been more notable; as it alſo ſeemed to be on our veſſel, if, inſtead of ſtriking it with the point of a pin, we caſt, though but faintly, againſt the lower part of it a grain of ſhot, leſs than a ſmall pin's head, or let a little grain fall from about one foot high, upon the inſide of the inverted hemiſphere. And to ſhew, that even ſoft and yielding bodies, and but faintly moved, are not to be excluded from a power of putting ſuch hard ones into motion; I ſhall add, that I found almoſt the like effects to thoſe abovementioned, by paſſing the pulp of my finger a little way along the lower part of the veſſel. Nay, that fluid bodies themſelves may communicate ſuch an inteſtine and propagable motion to hard and ſolid ones, I may have hereafter an occaſion to ſhew by the effects of a ſmall flame and the ſun-beams on glaſs and ſteel. And I ſhall here on this occaſion add this word about the propagation of motion produced in ſolid bodies by heat, that it much depends upon the particular textures of the bodies; for I found, that when I heated a piece of glaſs or of a fire-ſtone, I could without inconvenience hold my naked hand upon parts, that were very near (ſuppoſe within an inch off) the ignited portions of them: but, if we take a rod of iron, for inſtance, and heat one end red-hot, the heat of that end will be ſo propagated towards the other, that it will offend one's hand at ſeveral times the diſtance, at which one might conveniently hold the rod, if it were of glaſs.

In many buildings it may be obſerved, (and is thought a ſign of the firm coheſion of their parts,) that a ſtamp of one's foot, nay, or bear treading, or ſome ſuch other leſs briſk impulſe, made in one room, will have a ſenſible effect in all or moſt of the others. And it often happens, that, by the haſty ſhutting of a door, the whole houſe is made to tremble; whence we may argue, that, even among ſolid bodies, motion made in one place may be readily propagated to many others: and if, as to the latter of the inſtances, the ſudden impulſe and compreſſion of the air, made by the door ſuppoſed to be haſtily ſhut, have any conſiderable ſhare in the effect, the phænomenon will ſerve to ſhew the efficacy even of ſuch a motion of a fluid body, as we cannot directly feel upon divers large and firmly connected ſolid bodies.

A (highly probable) cauſe of earthquakes.

In earthquakes the tremulous motion ſometimes extends ſo very far, that though it ſeems high probable, that the ſhake, that is given to one part of the earth by the firing and exploſion of ſubterraneal exhalations, (if that be the true and only cauſe of earthquakes) is not capable of reaching near ſo far as divers earthquakes have done, but that the fire paſſes through ſome little ſubterraneal clefts, or channels, or hidden conveyances, from one great cavity or mine to another; yet it is not improbable, but that the vehemently tremulous motion does oftentimes reach a very great way beyond the places, where the exploſions were made; ſince, though *Seneca* would confine the extent of earthquakes to two hundred miles, yet obſervations made in this and the laſt century warrant us to allow them a far greater ſpread. The learned *Joſephus Acoſta* affirms, that in the kingdom of *Peru*, in the year 1586, an earthquake reached along the ſhore of the pacific ſea 160 leagues; and adds, that ſometimes it has in thoſe parts run on from ſouth to north 300 leagues. And in the beginning of this our age (*anno dom.* 1601) good writers relate a much larger earthquake to have happened, ſince it reached from *Aſia* to that ſea, that waſhes the *French* ſhores, and, beſides ſome *Aſiatic* regions, ſhook *Hungary*, *Germany*, *Italy*, and *France*, and conſequently a great part of *Europe*. And if that part of the narrative be certain, which relates, that this laſted not much above a quarter of an hour, it will be the more likely, that this earthquake ſhook great tracts of land beyond thoſe places, to which the fired matter, paſſing from one cavity to another, could reach in ſo ſhort a time: as you will the more eaſily gueſs, if you try, as I have done, that in trains of gunpowder itſelf the fire does not run on near ſo ſwiftly as one would imagine. But though I have been in more earthquakes than one; yet, ſince they were too ſudden and too ſhort to afford me any conſiderable obſervation, I ſhall ſay no more of them; but proceed to take notice, that oftentimes the motion of a coach or cart, that paſſed at a good diſtance from the place I was in, has made the buildings ſo ſenſibly ſhake, that I could not but wonder, that ſo great a portion of ſo firm and ſluggiſh a body, as the earth, could, by a cauſe, that ſeemed very diſproportionate to ſuch an effect, be made to tremble itſelf, and manifeſtly to ſhake firm buildings, that were founded on it. And this obſervation made me the more ininclinable to give credit to their relations, who tell us, that in a calm night, the march of a troop of horſe may be felt by attentive ſcouts watching at a great diſtance off, by the ſhake, that the ground receives from the trampling of the horſes; though I formerly ſuſpected much, and do yet a little, that the impulſe of the air conveyed along the reſiſting ſurface of the ground might mainly contribute to the effect, that is aſcribed only to the motion of the ſoil.

Natur. Quæſt. Lib. IV. *Cap.* 25.

Lib. III. *Cap.* 26.

Before I advance to the ſecond member of this chapter, it may not be impertinent to note, that in peculiarly diſpoſed bodies, and eſpecially in organical ones, a very languid motion may have a far greater effect, than it could produce by a bare propagation of itſelf. For it may ſo determine the motion of the ſpirits or other active parts of the body it works on, as to make multitudes of them act as if they conſpired to perform the ſame motions. As when a tickliſh man, by having the pulp of one's finger paſſed gently along the ſole of his foot or the palm of his hand, has divers muſcles and other parts of his body and face put into preternatural or unuſual motions. And moſt men, by being lightly tickled with the end of a feather or ſtraw within their noſtrils, have their heads and many parts of their bodies put into that violent commotion, wherein ſneezing conſiſts. And I remember, that having for ſome time been, by a diſtemper, (from which God was graciouſly pleaſed a while after to free me,) quite deprived of the uſe of my hands; it more than once happened to me, that ſitting alone in a coach, if the wind chanced to blow a ſingle hair upon my face in the ſummer time, the tickling or itching, that it produced, was ſo uneaſy to me, until by calling out to a footman I could get it removed, that, though I could well bear it as long as I was wont to do, when, having the uſe of my hands, I could relieve myſelf at pleaſure; yet if I were forced to endure the itching too long, before any came to ſuccour me, the uneaſineſs was ſo great, as to make make me apprehend falling preſently either into convulſions or a ſwoon. But it is time to proceed to the ſecond member of this chapter.

2. Others there are, that cannot believe, that local motion, eſpecially if it be languid, can be propagated through differing mediums, each of which, ſave that wherein the motion is begun, muſt, they think, either repel, or check and dead it. To theſe I ſhall recommend the conſideration of an experiment, I remember I made before ſome learned men in our pneumatick engine: for having cauſed a large thick glaſs receiver to be ſo blown, that it had a glaſs button in the inſide of that part, which upon the engine was to be placed upwards, I cauſed a watch to be ſuſpended by a little ſilver chain faſtned to that button by as ſlender and ſoft a body, as I thought would be ſtrong enough to ſupport my watch; and then, the glaſs being cemented on cloſe to the receiver, to prevent a commerce between the cavity of it and the air, the watch, that hung freely near the middle of the cavity of the receiver, made itſelf to be heard by thoſe attentive liſtners, that would hold their ears directly over the ſuſpended watch, whoſe motions were thereby argued to have been propagated either through the included air, or along the ſtring, to the concave part of the glaſs, and through the whole thickneſs of the glaſs to the convex part, and thence through the interpoſed air to the ear. And this mention of watches minds me of what I often obſerved in a ſmall ſtriking watch, that I have worn in my pocket: for when it ſtruck the hours, and in ſome poſtures, when the balance did but move, I could plainly feel the briſker motions of the bell, and ſenſibly the languid ones of the balance, through the ſeveral linings of my breeches, and ſome other interpoſed ſoft and yielding bodies; and this, though the watch (as I ſaid) was ſmall, and the balance included in a double caſe, and though the outwardmoſt were of (what they call) ſhagreen, and the innermoſt of gold; which I therefore mention, becauſe that cloſeſt of metals is obſerved more to dead ſounds and motions, than harder metals, as ſilver, copper and iron.

That motion may be propagated through differing mediums, may ſeem the more probable by the ſhakings, that are often felt by men lying on beds, that ſtand in rooms cloſe ſhut, when loud claps of thunder are produced (perhaps at a great diſtance off) in the clouds. And whether it will be fit to add to this inſtance that, which you have lately met with in the third chapter, of a wounded Frenchman at *Copenhagen*, I leave you to conſider.

I know not, whether it will be very proper to take notice, on this occaſion, of an odd phænomenon recited by the experienced *Agricola*, in theſe words: *Si animal dejicitur in autrum Viburgenſe, quod eſt in Carelia, regione Scandiæ, erumpit, ut perhibent, ſonus intolerabilis magno cum flatu: ſi leve pondus in ſpecum Dalmatiæ, quamvis, inquit Plinius, tranquillo die, turbini ſimilis emicat procella.* "If " you throw down an animal into the hole " of Viburg, which is in *Carelia*, a country " in *Scandia*, it is reported, that there breaketh " immediately forth a great and inſufferable " ſound, together with a ſtrong wind: " if a ſmall weight be thrown into the gap " of *Dalmatia*, though, ſays *Plinius*, in a " calm day, there is a ſtorm immediately " raiſed, not unlike that, which is occaſioned " by a whirlwind."

De nat. eorum quæ eff. e terra lib. 4. cap. 7.

3. As thoſe, of whom I took notice at the beginning of this chapter, are backward to allow, that motion may be conſiderably propagated through ſolid bodies; ſo on the contrary, there are others, that are indiſpoſed to think, that it is near ſo propagable, as indeed it is through fluid bodies; becauſe they preſume, that the eaſy ceſſion of the parts of fluids will dead the impulſe received by thoſe of them, that are firſt acted on by the impelling body. And

4. There is yet another ſort of naturaliſts, who, though they may be brought to grant, that motion may be propagated even through a ſoft and yielding medium, cannot believe, that it ſhould through ſuch a medium be propagated to any conſiderable diſtance; being perhaps induced to this opinion by obſerving, that, though a body ſomewhat broad as well as ſolid, as the palm of one's hand, or a battledore, be moved through the air ſwiftly enough to make a wind; yet that wind will not be ſtrong enough to be felt any more than a very little way off. Wherefore, becauſe the inſtances, to which I aſſign the remaining part of this chapter, may be for the moſt part applicable to the removal of both theſe prejudices; it may, for brevity ſake, be expedient to conſider them both together.

Des Cartes judgment of light.

If luminous bodies act on our eyes, not by a ſubſtantial diffuſion of extremely minute particles, as the atomiſts would have it, but by a propagated pulſion of ſome ſubtile matter contiguous to the ſhining body, (as the Carteſians, and many other philoſophers maintain) it will be manifeſt, that a body leſs than a ſmall pin's head may give a briſk motion to a proportion of fluid matter, many millions of times greater than itſelf; ſince in a dark night a ſingle ſpark of fire may be ſeen in differing places, whoſe diſtance from it exceeds many thouſand times the ſpark's diameter: not to mention the great remove, at which the flame of a ſmall taper may not only be ſeen, but appear greater than near at hand. And if we compare the diameter of that bright planet Venus, which yet ſhines but with a borrowed and reflected light, with its diſtance from the earth, we may eaſily conclude, that the fixed ſtars, which probably are ſo many ſuns, that ſhine by their own native light, muſt impel a ſtupendous proportion of ætherial matter, to be able at that immenſe diſtance to make ſuch vivid impreſſions, as they do, upon our eyes. But to deſcend to inſtances leſs remote and diſputable, I ſhall, in order to the removal of the two lately mentioned prejudices, proceed to conſider; that, though it be true, that fluid bodies do eaſily yield to ſolid ones, that

A probability, that the fixed ſtars are ſo many ſuns.

impel them, and thereby oftentimes quickly dead the motion of thoſe ſolids; yet the motion being loſt only in regard of the ſolid body, is not loſt, but tranſmitted and diffuſed in reference to the fluid; as when a log of wood, or any ſuch body ſpecifically lighter than water, is let fall in the middle of a pond, though its progreſs downwards be checked, and it be brought to reſt quietly on the ſurface of the water, yet its motion is not loſt, but communicated to the parts of the water it firſt ſtrikes againſt, and by thoſe to others, till at length the curls or waves produced on the ſurface of the water ſpread themſelves, till they arrive at the brinks, and would perhaps be farther expanded, if theſe did not hinder their progreſs. From which inſtance we may learn, that, though the nature of fluid bodies, as ſuch, requires, that their parts be actually diſtinct and ſeparately moved, yet the particular corpuſcles, that compoſe them, being (at leaſt here below) touched by divers others, the new motion, that is produced in ſome of them by an impellent ſolid, muſt needs make them impell the contiguous corpuſcles, and theſe thoſe that chance to lye next to them; and ſo the impulſe may be propagated to a diſtance which you will the more eaſily believe may be great, if you conſider with me, both that in a fluid body the corpuſcles, being already in the various motion requiſite to fluidity, yield more eaſily to the impellent, and alſo that being fully, or very near it, counterpoiſed by others of the ſame fluid, a ſcarce imaginably little force may ſuffice to impel them; inſomuch that, though the braſs ſcale of a balance, of divers inches in diameter, may well be ſuppoſed to outweigh many myriads of ſuch particles as compoſe water, wine, &c. yet, (as I elſewhere more fully relate) when ſuch a ſcale was duly counterpoiſed with another like it, I could eaſily put it into various motions only with the inviſible effluvia of no great piece of amber. And if we conſider that obvious inſtance of the ſwelling circles made by caſting a ſtone into a pond, or other ſtagnant water, we ſhall be the more eaſily perſuaded, that, even in a heavy fluid, a motion may reach a far greater way, than men are uſually aware of, beyond the parts, on which it was firſt impreſſed.

On this occaſion I muſt not omit a ſtrange obſervation given me by a very experienced navigator, that much frequents the Coaſt of *Groenland*, and other arctick regions, to fiſh for whales: for this perſon being diſcourſed with by me about the effects of the breaking of thoſe vaſt piles of ice, that are to be met with in thoſe parts, aſſured me, that not only he had often heard the ice make, in breaking, a terribler noiſe than the loudeſt claps of thunder with us, but that ſometimes, when the ſea-water had, as it were, undermined the foundation of the mountainous piece of ice, he has known it at length ſuddenly fall into the ſubjacent ſea, with ſo much violence as to make a ſtorm at a great diſtance off; inſomuch that once, when he lay two leagues off the place, where this ſtupendous maſs of ice fell, it made the waves go ſo high, as to waſh clear over the ſtern of the ſhip, with danger enough to ſome of his men, and to ſink ſeveral of his ſhallops, that were riding by, though ſcarce any ſmall veſſels in the world uſe to be ſo fitted for rough ſeas, as thoſe about *Groenland*.

And whereas, though the air be a much thinner fluid, we are apt to think it indiſpoſed to propagate motion far, give me leave to tell you, that we take wrong meaſures, if we think, that (for inſtance) the undulating motion, into which the air is put by the action of ſonorous bodies, reaches but a little way, as we are apt to preſume it does, becauſe we judge of it by the effect it has on our ears, when the ſound is made in diſadvantageous places. For one, that, for inſtance, hears a lute or a viol played on in a room furniſhed with hangings, will be apt to think the ſound faint and languid, in compariſon of what it would appear to him, if the ſame inſtrument were played on after the ſame manner in an arched room without hangings; theſe ſoft and yielding bodies being apt to dead the ſound, which the figure and hardneſs of the vaulted room would reflect. And ſo, when a man ſpeaks aloud in the free air, we are not wont to take any notice of a progreſs made by the motion of the air beyond the place we are in, when our ears receive the ſound; but if the place happen to be furniſhed with echo, though at many times that diſtance from the ſpeaker, we may then eaſily take notice, that the motion of the air was carried on, and that with good vigour, to a far greater diſtance, than elſe we ſhould have obſerved. And I have often thought, that, even by the better ſort of our echoing places, we are not informed to near how great a ſphere the motion, which the air is put into by ſounds, may extend itſelf, where its diffuſion and vigour are not hindered nor weakened by bodies, either placed too near, or indiſpoſed to promote its operation.

From. Meteor. lib. 2. *art.* 9.

What has been lately ſaid of the great diffuſion of ſounds, if themſelves be loud and great, will appear highly probable, by what is related by the learned *Fromundus*, who being profeſſor of philoſophy at *Louvain*, in the year 1627, had opportunity enough to know the truth of what he relates; namely, that at the famous ſiege of *Oſtend* in *Flanders*, the thunder of the great ordnance was heard at above thirty Dutch leagues, which, according to the vulgar reckoning, amounts to a hundred and twenty of our Engliſh miles; and that is yet, as he truly obſerves, more ſtrange, and makes more for our preſent purpoſe, which he adds concerning the diffuſion of the ſound of a drum, which, he ſays, was, upon a time, heard at ſea twelve leagues off.

But to return to what I was ſaying of ecchos, to confirm my conjecture about them, I ſhall think it needleſs to offer you any other argument, than that, which you will draw yourſelf from the notable relation I met with in the learned *Varenius*, of an obſervation *Geograph. general. lib. 1. c. 19.* made by *David Frœliebius*, who, in the company of a couple of ſtudents, had the curioſity (in the month of *June*) to viſit the mountain *Carpathus*, eſteemed the higheſt of all the Hungarian hills, and ſaid to be much more ſteep and difficultly acceſſible, than any of the Alps themſelves. *Frœlichius* then (in my author) having related with what difficulty he and his companions aſcended above that region of the air, where they met with clouds and vehement winds, adds this memorable obſervation, for whoſe ſake I mention the ſtory: *Exploſi* (ſays he) *in ea ſummitate ſclopetum, quod non majorem ſonitum primò præ ſe tulit, quam ſi tigillum vel bacillum confregiſſem; poſt intervallum autem temporis murmur prolixum invaluit, inferioréſque montis partes, convalles, et ſylvas opplevit. Deſcendendo per nives annoſas intra convalles, cùm iterum ſclopetum exonerarem, major et horribilior fragor quàm ex tormento capaciſſimo inde exoriebatur: hinc verebar, nè totus mons concuſſus mecum corrueret; durávitque hic ſonus per ſemiquadrantem horæ, uſque dum abſtruſiſſimas cavernas penetraſſet, ad quas aer undique multiplicatus reſiliit. Et talia quidem objecta concava in ſummitate ſe non illicò offerebant, idcirco ferè inſenſibiliter primùm ſonus repercutiebatur, donec deſcendendo antris et convallibus vicinior factus ad eas fortiùs impegit.* “I diſcharged a piſtol, being upon the top of the hill, which at firſt made no greater noiſe than that, which uſually happens at the breaking of a ſmall rod; but after a little while the noiſe became ſtronger, and filled the lower parts of the hill, the vallies, and neighbouring woods. Now coming down lower through ſnow, that had lain there ſeveral years, and having diſcharged again the piſtol, the noiſe became, on a ſudden, louder, than that of the greateſt guns: which gave me ſome grounds to fear, that the whole hill, being thus ſhaken, ſhould at length ſubſide: this ſound laſted half a quarter of an hour, till it had penetrated into the remoteſt grotto's, whence the parts of the air thruſting one another had been ſtrongly reverberated; and becauſe no ſuch concavities were in the top of the hill, the ſound was firſt inſenſibly reverberated, till coming lower and nearer the grotto's and vallies, it was ſtrongly daſhed againſt them.”

CHAP. VI.

OBSERVATION. V.

Men uſually think not, what the modification of the inviſible motion of fluids may perform on the diſpoſed bodies of animals.

In this obſervation I expreſly mention the diſpoſed bodies of animals, to intimate, that there is a peculiar aptitude required in thoſe animals, or ſome particular parts of them, that are to be ſenſibly affected by ſuch motions, as we are treating of, which would otherwiſe be too languid to have any ſenſible operation on them.

It ſeems the leſs ſtrange to me, that continuing ſounds, and other ſomewhat durable impulſes of the air or other fluids, ſhould have a manifeſt operation upon ſolid bodies, when I conſider the multitude of ſtrokes, that may in a very ſhort, and perhaps ſcarce obſervable time, be ſuppoſed to be given by the parts of the fluid to the conſiſtent body: for though each of theſe ſingle would perhaps be too languid to have any ſenſible effect at all; it being opportunely and frequently repeated by the ſucceſſive parts of the fluid, as by ſo many little ſwimming hammers or flying bullets, they may well have a notable effect upon the parts of a body expoſed to their action: as may be argued from the great ſwing, that may be given to pendulums, by a very languid force, if it ſucceſſively ſtrike the ſwinging body, when having finiſhed its excurſion, it is ready to return towards the perpendicular; as alſo from the tremulous motion, that is imparted even to the metalline ſtring of a muſical inſtrument, by the congruous motion the air is put into by another trembling ſtring, (as there may be hereafter occaſion to declare.)

I REMEMBER *Scaliger* tells a pleaſant ſtory of a knight of *Gaſcony*, whom the ſound of a bagpipe would force preſently to make water; adding, that a perſon diſobliged by this man, and reſolving to be merrily revenged on him, watched a time when he ſate at a feaſt, ſo as he could not well get out, and brought a bagpiper to play unwares behind him; which he did ſo unluckily, that the muſick had preſently its wonted effect upon the poor knight, to his great confuſion, and the laughter of the company. On which occaſion I ſhall add, that I know a very ingenious gentleman, who has confeſſed to me, that the noiſe of a running tap is wont to have almoſt the like operation upon him.

It is a common obſervation, that the noiſe, that an ungreaſed cartwheel makes in grating againſt the axel-tree, and the ſcraping of a knife upon a plate of ſilver or pewter, and ſome other briſk and acute ſounds, do ſo affect divers parts of the head, as to produce that effect, that is commonly called ſetting the teeth on edge; which, whether it proceed from any commerce between the auditory nerves, and thoſe, that are inſervient to the motion we have mentioned, I leave anatomiſts to conſider. But theſe effects of acute ſounds are much leſs conſiderable than that, which I elſewhere relate of an ingenious domeſtick of mine, who ſeveral times complained, that the tearing of brown paper made his gums bleed; which argued, that the ſound had an operation not only upon the nervous and membranous parts, but the blood and humours themſelves.

SIR HENRY BLOUNT, in his voyage to the *Levant*, giving an account of what he obſerved in *Egypt*, has, among other remarkable things, this paſſage: many rarities of living creatures I ſaw in *Grand Cairo*, but the moſt ingenious was a neſt of four-legged ſerpents of two feet long, black and ugly, kept by a Frenchman, who, when he came to handle them, they would not endure him, but ran and hid in their hole; then would he take his cittern and play upon it; they hearing his muſick, came all crawling to his feet, and began to climb up him, till he gave over playing; then away they ran.

THIS recalls to my mind, what ſome men of repute, and particularly the learned *Kircherus*, relate concerning a great fiſh, in or about the ſtreights, that ſever *Sicily* from *Italy*, which is ſaid to be much affected with a peculiar kind of tune, (harſh enough to human ears) by which the mariners are wont to allure it to follow their veſſels. And it may much ſtrengthen the concluſion maintained in this chapter, if there be any certainty in the famous tradition, that the lion is terrified, and made to run away by the crowing of a cock: I ſay *if*, becauſe though I doubt not but ſome peculiar kinds of ſounds, as well as of other ſenſible objects, may be particularly and exceedingly ungrateful to the ſenſories of this or that peculiar kind of animals, and conſequently to the ears of lions; yet a late French traveller into the *Levant* gives me cauſe much to queſtion the matter of fact, affirming, that rowing along the brink of *Tigris* or *Euphrates*, (for I do not punctually remember which) they were, for many hours in the night, terrified by lions, that attended them along the brink of the river, and would not at all be frighted by the frequent crowing of the cocks, that chanced to be in the paſſengers boat: of which unconcernedneſs of the lions our obſerving traveller took much more notice, than the lions appeared to do of the crowing of the cocks. I might, on this occaſion, ſay ſomething of the received tradition, that many ſleeping perſons will be more eaſily waked by being called upon by their own uſual names, than by other names, though uttered with a louder voice: but this it may ſuffice to have mentioned; nor will I here inſiſt on that more certain example of the operation of a ſound, which is afforded by the ſtarting of men or greater animals, upon a ſurpriſing, though not vehement noiſe; though this oftentimes puts ſo many of the ſpirits and muſcles into motion, that the whole bulk of the animal is ſuddenly raiſed from the ground, which perhaps it could not be by the bare counterpoiſe of ſome hundreds of pounds: this, I ſay, I will not in this place inſiſt on, becauſe the phænomenon ſeems to depend rather upon the loudneſs or acuteneſs of the ſound, than upon any determinate modification of it, particularly relating to the animal itſelf.

Lions frighted by the crowing of cocks, a vulgar error.

BUT the eminenteſt inſtance of the efficacy of peculiarly modified ſounds upon diſpoſed bodies is afforded by what happens to thoſe, which are bit by a tarantula: for though the bitten perſon will calmly hear divers other tunes, yet when a peculiarly congruous one comes to be played, it will ſet him a dancing with ſo much vigour, as the ſpectators cannot but wonder at, and the dancing will ſometimes continue many hours, if the muſick do ſo, and not otherwiſe. I know there are ſome, that queſtion the truth of the things related of theſe Tarantati, (as the Italians call them) and I eaſily grant, that ſome fictions may have been ſuffered to paſs under the countenance of ſo ſtrange a truth: but beſides the affirmations of ſome learned men, (as well phyſicians as others) my doubts have been much removed by the accounts I have received from an ingenious acquaintance of mine own, who at *Tarentum* itſelf, whence the inſect takes its name, and elſewhere, ſaw many bitten perſons in their dances, ſome in publick and ſome in private places, and amongſt the reſt a phyſician, on whom the tune, that fitted his diſtemper, had the ſame operation as on the other patients. And the learned *Epiphanius Ferdinandus*, who practiſed phyſick in *Apulia* and *Calabria* for many years, not only delivers, upon his own perſonal obſervation, ſeveral narratives of the effects of muſick upon the Tarantati, but invites any, that may doubt of the truth of ſuch narratives, to repair to him at a fit ſeaſon, undertaking to convince them by ocular demonſtration.

See *Sandys*'s travels.

I KNOW a very honeſt and ſober muſician, who has divers times affirmed to me, that he could at pleaſure, by playing a certain tune, (which he acquainted me with, and which did not move others) make a perſon (whom he named to me) weep, whether ſhe would or no. And I might add, that when I have been taking phyſick, or am any thing feveriſh, the repetition of two verſes of *Lucan* ſeldom fails (as I have often tried) of producing in me a chilneſs, almoſt like that, but fainter, that begins the fit of an ague. But on this inſtance I look not, as a ſtrong proof of the phyſical efficacy of ſounds; becauſe thoſe two verſes having been emphatically read, when divers years ago I lay ſick of a ſlow fever, and could not reſt, they made ſo ſtrong an impreſſion on me, that whenever I am under a diſcompoſure any thing near like that, that then troubled me, thoſe verſes revive, as it were, in my brain and ſome other parts, that diſpoſition, or rather indiſpoſition, with which my firſt hearing of thoſe verſes was accompanied.

IT may be the leſs admired, that the vibrating motion of the air, that produces ſounds, ſhould have ſuch effects upon diſpoſed organical bodies; ſince light itſelf, which either conſiſts of briſkly moving effluvia, far more ſubtile than aerial corpuſcles, or is propagated by the pulſe of a far more ſubtile body than air, may have a notable operation upon diſpoſed bodies: for we commonly obſerve, that the ſunbeams, by beating upon the face or eyes of ſome, that come ſuddenly out of a ſhaded place into the light, preſently make them ſneeze; which, you know, is not done without a vehement motion of divers parts of the body. And though colour be but a modification of light; yet, beſides that it was anciently a practice, as the hiſtory of the *Maccabees* informs us, to ſhew red objects to elephants, to make them more fierce, it is a familiar obſervation, that red cloaths do offend and irritate turky-cocks. And that is more remarkable, which is related by the very learned phyſician *Valeſius*, of a perſon, that he knew, who, if he looked upon red objects, would not only have his eyes offended, but was ſubject to an effuſion of humours in the neighbouring parts.

CHAP. VII.

OBSERVATION VI.

Men ſuſpect not, what efficacy the inviſible motions of fluids may have, even upon inorganical bodies, upon the ſcore of ſome determinate congruity or relation betwixt a peculiar texture of the one, and the peculiar modification of the other's motion.

THOUGH the experiments delivered in the foregoing chapter have, I preſume, ſufficiently manifeſted, that the modification given to the motions of the air by ſonorous bodies may have conſiderable effects upon animals, in whoſe organized bodies the curiouſly contrived parts have an admirable connexion with, and relation to one another, and to the whole ſymmetrical fabrick they make up; yet, I fear, it will ſcarce ſeem credible, that ſonorous motions of the air, not very loud, ſhould find, even in bodies inanimate and inorganical, ſuch congruous textures and other diſpoſitions to admit their action, that even more languid ſounds, peculiarly modified, may ſenſibly operate upon them, and much more than ſounds, that are louder and more vehement, but not ſo happily modified. To make this good by particular experiments, I ſhall begin with that, which, though the effect may ſeem inferior to that of moſt of the others, I judge fitteſt to manifeſt, that the produced motion depends upon the determinate modification of that of the impellent fluid.

THAT a certain impulſe of air, made by one of the uniſon-ſtrings of a muſical inſtrument, may ſuffice to produce a viſible motion in another, is now become a known experiment; of the cauſe and ſome unobſerved phænomena of which I elſewhere more fully diſcourſe. But, that it may not be ſuſpected in this caſe, that the ſhake of the untouched ſtring is communicated to it by the propagated motion of the inſtrument itſelf, to which the ſtring, that is ſtruck, is alſo faſtened; I ſhall add, that, according to what I elſewhere relate, I found by trial purpoſely made, that a ſtring of wire, (which you will grant to be a more ſolid body, than an ordinary gut-ſtring) may be, without another ſtring, brought to tremble by a determinate ſound made at a diſtance, which produced but ſuch an impulſe of the air, as could neither be ſeen nor felt by the by-ſtanders, nor would communicate any ſenſible motion to the neighbouring ſtrings. It is true, that in this caſe the ſtring, in which the trembling was produced, was a ſingle, long, ſlender and ſpringy body, faſtened at both ends to a ſtable one; and therefore it may ſeem altogether groundleſs to expect, that any thing like this effect ſhould be by the ſame cauſe produced in bodies, that do not appear ſo qualified. But, as we elſewhere ſhew, that a certain degree or meaſure of tenſion is in order to this phænomenon the principal qualification, without which all the other would be unavailable; perhaps it will not be abſurd to inquire, whether, in bodies of a very differing appearance from ſtrings, the various textures, connexions and complications, that nature or art, or both, may make of the parts, may not bring them to a ſtate equivalent to the tenſions of the ſtrings of muſical inſtruments, whereby divers of the mentioned parts may be ſtretched in the manner requiſite to diſpoſe them to receive a vibrating motion from ſome peculiar ſounds; and whether theſe trembling parts may not be numerous enough to affect their neighbours, and make, in the body they belong to, a tremulous motion diſcernible, though not by the eye, yet by ſome other ſenſe. This conjecture, or inquiry, you will, I hope, have the leſs unfavourable thoughts of, when you ſhall have conſidered the following experiments.

I REMEMBER, that many years ago I found by trial, that, if a ſomewhat large and almoſt hemiſpherical glaſs, though not very thin, were conveniently placed, a determinate ſound, made at a convenient diſtance from the concave ſurface of the glaſs, would make it ſenſibly ring, as a bell does a while after it has been ſtruck: but this noiſe was the effect of a determinate ſound; for, though the voice were raiſed to a higher tone, or if the ſound were made louder, the ſame effect would not enſue. I remember alſo, that, ſome years after, I obſerved, that large empty drinking-glaſſes of fine white metal had each of them its determinate tenſion, or ſome diſpoſition, that was equivalent, as to our purpoſe. For, cauſing the ſtrings of a muſical inſtrument to be variouſly ſcrewed up, and let down, and briſkly ſtruck, we found, as I expected, that the motion of one ſtring, when it was ſtretched to a certain note or tone, would make one of the glaſſes ring, and not the other; nor would the ſound of the ſame ſtring, tuned to another note, ſenſibly affect the firſt glaſs, though perhaps it might have its operation upon another. And this circumſtance is not, on this occaſion, to be omitted, that, after we had found the tone proper to one of the glaſſes, and ſo tuned the ſtring, that, (I ſay) when that was ſtruck, the glaſs would reſound. Having afterwards broken off a part of the foot of the glaſs, yet not ſo much, but that it continued to ſtand upright,

right, the ſame ſound of the ſtring would no longer be anſwered by the veſſel, but we were obliged to alter the tenſion of the ſtring, to produce the former effect. The learned *Kircherus*, as I have been informed, ſomewhere mentions a correſpondence between ſome liquors and ſome determinate ſounds; which I ſuppoſe may be true, though the trial did not ſucceed with me, perhaps for want of ſuch accommodations for ſo nice an experiment, as I could have wiſhed, but could not procure: but if you can, you will oblige me to make the trials ſo, as to ſatisfy yourſelf and me, whether the agitation of the liquor be cauſed immediately by the motion of the air, or be communicated by the intervention of the tremblings of the veſſel.

AN artiſt, famous for his ſkill in making organs, anſwered me, that, at ſome ſtops of the organs, ſome ſeats in the church would tremble. But becauſe I ſuſpected by his relation, that the greatneſs of the ſound chiefly effected it, becauſe when that pipe, which they call the open *diapaſon*, ſounds, the chair or ſeat, on which the organiſt ſits, and perhaps the neighbouring part of the organ trembles; I ſhall add, that I have divers times obſerved certain ſounds of an excellent organ to make not only the ſeat I ſate on in the church tremble under me, but produce an odd tremulous motion in the upper part of my hat, that I could plainly feel with my hands. And that, which makes me apt to believe, that this effect depends upon the determinate tone, rather than upon the loudneſs of the ſound, is, that I have oftentimes felt, and diligently obſerved, ſuch a kind of motion in the upper part of my hat, upon the pronouncing of ſome words in ordinary diſcourſe; in which caſe the effect could not with probability be referred to the greatneſs of the ſound, but its peculiar fitneſs to communicate ſuch a motion to a body ſo diſpoſed.

NOR is it only in ſuch ſmall and yielding bodies, as hats and ſtrings, that ſounds, that are not boiſterous, may produce ſenſible effects; for, if they be congruous to the texture of the body they are to work on, they may excite motions in it, though it be either ſolid or very bulky: of which I ſhall here ſubjoin a couple of inſtances.

AN ancient muſician affirmed to me, that, playing on a baſe viol in the chamber of one of his ſcholars, when he came to ſtrike a certain note on a particular ſtring, he heard an odd kind of jarring noiſe, which he thought at firſt had either been caſual, or proceeded from ſome fault in the ſtring; but having afterwards frequent occaſion to play in that ſame room, he plainly found, that the noiſe he marvelled at was made by the tremulous motion of a caſement of a window, which would be made to tremble by a determinate ſound of a particular ſtring, and not by other notes, whether higher or lower.

To this firſt inſtance I ſhall add the ſecond, which, I confeſs, I was not forward to believe, till trial had convinced me of the truth; and I ſcrupled it the rather, becauſe, if the reflection of determinate ſounds ſhould appear to proceed from the peculiar kind of tremulous motion, into which the parts of the reſonant body are put, it may incline men to ſo great a paradox, as to think, that ſuch a motion of the air, as our bodies do not feel, may produce a trembling in ſo ſolid a body, as a ſtone-wall of a great thickneſs. The experiment or obſervation itſelf I ſhall give you in the ſame words I ſet it down ſome hours after I made it, which were theſe.

YESTERDAY I went to ſatisfy myſelf of the truth of what had been told me by an ancient muſician, to whom I had been relating, what I had obſerved of the effects of ſome determinate ſounds even upon ſolid bodies, and of whom I inquired, if he had met with any thing of the like nature: taking him along with me, I found, that though the place be but an arch, yet it would not anſwer to all notes indifferently, when we ſtood in a certain place, but to a determinate note, (which he afterwards told me was *Ce fa ut* a little flatted,) to which note it anſwered very reſonantly, and not ſenſibly to others, which we made trial of, whether higher or lower than it: and (which added to the ſtrangeneſs) when I made him raiſe his voice to an eighth; as conſonant as thoſe two ſounds are wont to be in all other caſes, the vaulted arch did not appear to us affected with the note. The muſician added, that he had tried in moſt arches all about the city, and could not find ſuch a peculiarity in them, as being to be made reſonant by all notes or ſounds indifferently, that were ſtrong enough; and alſo, that as this arch for this hundred years has been obſerved to have this property, ſo an ancient and experienced builder informed him, that any vault, that were exquiſitely built, would peculiarly anſwer to ſome determinate note or other.

CHAP. VIII.

OBSERVATION VII.

Men look upon divers bodies, as having their parts in a ſtate of abſolute reſt, when indeed they are in a forced ſtate, as of tenſion, compreſſion, &c.

THIS obſervation will probably ſeem paradoxical; for when an entire body, eſpecially if it be of a ſolid conſiſtence, and ſeem to be of an homogeneous or uniform matter, appears to be moveleſs, we are wont to take it for granted, that the parts, which that body is made up of, are perfectly at reſt alſo. But yet this will ſcarce be thought a reaſonable ſuppoſition, if we do but rightly conſider ſome obvious phænomena, which may teach us, that whilſt a whole body, or the ſuperficies, that includes it, retains its figure, dimenſions and diſtance from other ſtable bodies, that are near it, the corpuſcles, that compoſe it, may have various and briſk motions and endeavours among themſelves. As when a bar of iron or ſilver, having been well hammered, is newly taken off of the anvil, though the eye can diſcern no motion in it, yet the touch will readily perceive it to be very hot; and, if you ſpit upon it, the briſk agitation of the inſenſible parts will become viſible in that, which they will produce in the liquor. Beſides, when the lath of a croſs-bow ſtands bent, though a man do neither by the eye nor the touch perceive any motion in the ſpringy parts; yet, if the ſtring be cut or broken, the ſudden and vehement motion of the lath, tending to reſtore it to the figure it had before it was bent, diſcovers a ſpringineſs; whence we conclude it was before in a ſtate of violent compreſſion. And though the ſtring of a bent bow do likewiſe appear to be in a ſtate of reſt; yet, if you cut it aſunder, the newly made extreams will fly from one another ſuddenly and forcibly enough to manifeſt, that they were before in a violent ſtate of tenſion. And on this occaſion I could add divers inſtances taken not only from the works of art, but thoſe of nature too, if they did not belong to another paper: but one ſort of obſervations it will be proper to ſet down in this place; becauſe in thoſe already mentioned, the bow and ſtring were brought into a violent ſtate by the meer and immediate force of man. I ſhall therefore add, that there are divers bodies, in which, though no ſuch kind of force appears to have antecedently acted on them, we may yet take notice of a ſtate of violent compreſſion or extenſion, and a ſtrong endeavour or tendency of the parts, that to the eye or the touch ſeem at reſt, to ſhrink or to fly out; and this endeavour may in ſome caſes be more laſting and more forcible, than one would eaſily ſuſpect or believe. But examples of this kind you muſt not expect that I ſhould give you out of claſſick authors, ſince in them it is like you have not met with either an inſtance or a conjecture to this purpoſe; but ſome few things, that I tried myſelf, and ſome others, that I learnt by inquiry from ſome tradeſmen, whom I judged likelieſt to inform me, I ſhall briefly acquaint you with.

I HAVE ſometimes obſerved myſelf, and have had the obſervation confirmed to me by the ingeniouſer traders in glaſs, that a glaſs, that ſeemed to have been well baked, or nealed, (as they call it,) would ſometimes, many days or weeks, or perhaps months, after it is taken from the fire, crack of its own accord; which ſeems for the moſt part to happen upon the ſcore of the ſtrong, but unequal, ſhrinking of the parts of the glaſs. And the glaſs-men will tell you, that if they take their glaſſes too haſtily from the fire, not allowing them leiſure to cool by degrees, they will be very apt to crack. But I remember, that, to ſatisfy ſome ingenious men, I deviſed a way of exhibiting a much more quick and remarkable phænomenon of that kind. Having made then, by a way I elſewhere teach, a flat lump of metalline glaſs, two or three or four times as thick, as an ordinary drinking-glaſs, I obſerved, as I expected, that, though it had been melted in a very gentle fire, its very fuſible nature needing no other; and though it were removed but very little from the fire, it was ſo diſpoſed to ſhrink upon a ſmall degree of refrigeration, or rather abatement of heat, that, before it was ſenſibly cold, it would crack with a noiſe in ſo vehement a manner, that, notwithſtanding the ponderouſneſs of the matter, which had been purpoſely laid upon a level, parts of a conſiderable bulk, weighing perhaps ſome drams, would fly to a not inconſiderable diſtance from one another. And this experiment I took pleaſure to make more than once. And if you will be content with an inſtance, which, though otherwiſe much inferior, may not be unwelcome, for its being eaſily and readily made, I ſhall offer you one, that I have often repeated. Take a piece of copper, (if the plate be thick, it is ſo much the better,) and having throughly brought it to a red or white heat among kindled coals, take it from the fire, and when it begins to cool a little, hold it over a ſheet or two of white paper, and you will perceive good ſtore of flakes to fly off, not without ſome little noiſe, one after the other, and ſometimes perhaps as far, as the farthermoſt edges of the paper; which flakes or ſcales ſeem, by their brittleneſs and colour, to be but parts of the ſurface of the metal vitrified by the vehement action of the fire, and afterwards by a too haſty refrigeration ſhrinking ſo violently, as to crack and leap from one another, like the contiguous parts of the ſtring of a viol or other muſical inſtrument, that breaks by the moiſture of the air. And on this occaſion I ſhall add, that having afterwards inquired of an expert artificer, that made metalline concaves, about the ſhrinking of his mixtures of metals, he confeſſed to me, that he uſually obſerved them to ſhrink upon refrigeration. And the like I myſelf have obſerved in iron of a great thickneſs, and purpoſely fitted to a hollow body of metal, which it would not enter when it was ignited, though it would when it was cold. But to ſhew you by a notable inſtance or two, both that metals may ſhrink, and that they may do ſo with a very conſiderable force, I ſhall add, that I found by inquiry, that the lately mentioned artificer, after he had made ſome large concaves of an unfit mixture of metals, and having removed them from the fire, had been very careful to keep the cold air from them, leſt they ſhould cool too haſtily; obſerved yet, to his great loſs, that, when they came to be further refrigerated, they would (perhaps after three hours) crack with a great noiſe, though this metalline mixture were perchance harder than iron, and three or four times as thick as common looking-glaſſes. But the misfortune of another tradeſman afforded me a yet more conſiderable phænomenon. For this excellent artificer, whom I often employ, and with whom I was a while ſince diſcourſing of theſe matters, complained to me, that having lately caſt a kind of bell-metal upon a very ſtrong ſolid inſtrument of iron of a conſiderable ſuperficial area, though the metal were ſuffered in a warm room to cool, from about eight o'clock on Saturday night till about ten or twelve on Monday morning, and were then (which is to be noted) conſiderably hot to the touch; yet it cooled ſo far, that, ſhrinking from the iron, that would not ſhrink with it, the bell-metal cracked in divers places with noiſes loud as the report of a piſtol, though the metal, he affirmed to me, was an inch and an half, or two inches thick. And the ſame perſon ſhewed me a large cylinder of iron, about which, for a certain purpoſe, a coat of bell-metal had been caſt ſome days before; on which (bell-metal) there was a crack near one end made by the coldneſs of the iron, though the thickneſs of the bell-metal, as near as I could meaſure it, exceeded an inch, and (as the workman affirmed) an inch and a quarter.

Nor is it only in ſuch mixtures as bell-metal, which, though very hard, may be very brittle, but even in a metal, that is malleable when cold, that the like phænomenon may be met with, as I have been aſſured by another ingenious artificer, of whom I inquired, whether he had taken notice of the ſhrinking of metals; who affirmed to me, that having had occaſion to caſt about a cylinder of iron a ring or hoop of braſs, he found, to his trouble, that, when the metal began to cool, the parts ſhrunk from one to another ſo, as to leave a gaping crack, which he was fain to fill up with ſoder quite croſs the breadth of the ring, though this were above an inch thick.

I should not, *Pyrophilus*, have in this chapter entertained you with more experiments of others, than of my own, if I had the conveniency of living near founders of metals, as the tradeſmen had, whoſe obſervations I have recited, and whoſe ſincerity in them I had no cauſe to queſtion; and both their experiments and mine ſeem to teach, that a body may be brought into a ſtate of tenſion, as well by being expanded and ſtretched by the action of the fire upon the minute parts, as by the action of an external agent upon the intire body. And, to ſpeak more generally, the ſtate of violent contraction and compreſſion may not unfitly be illuſtrated by a bow, that is bent. For, as the bow itſelf is brought to a ſtate of compreſſion by the force of the archer, that bent it; ſo by the elaſtical force of the bent bow the ſtring is brought into a violent ſtate of tenſion, as may be made evident by the cutting off the ſtring in the middle; for then both the bow will fly ſuddenly outwards, and the parts of the ſtring will ſwiftly and violently ſhrink from one another. And, according to this doctrine, the effect of other bodies upon ſuch, as are thus brought into, what men call a preternatural ſtate, is not to be judged barely according to uſual meaſures, but with reſpect to this latent diſpoſition of the patient: as, for inſtance, though the ſtring of a violin not ſcrewed up will not be hardened by the vapours, that imbue the air in moiſt weather; yet a neighbouring ſtring of the ſame inſtrument, though perhaps much ſtronger, being ſcrewed up, and thereby ſtretched, will be ſo affected with thoſe vapours, as to break with noiſe and violence. ſo when one part of a piece of glaſs is made as hot as can be, without appearing diſcoloured to the eye, though a drop or two of cold water have no effect upon the other part of the ſame glaſs, yet if it touch the heated part, whoſe wonted extenſion (as I have elſewhere proved) is altered by the fire, that vehemently agitates the component particles; the cracking of the glaſs will almoſt always preſently enſue.

If againſt theſe inſtances it be alledged, that it is poſſible to aſſign another cauſe of the ſeemingly ſpontaneous breaking of the bodies mentioned in this chapter, than that which I have propoſed, it will not much concern this diſcourſe to examine the allegation; for, whatever the latent cauſe of the phænomena may be, the manifeſt circumſtances of them ſuffice to ſhew, that bodies, which as to ſenſe, are in a natural ſtate of reſt, may be in a violent one, as of tenſion, and may have, either upon the ſcore of the contexture of the parts among themſelves, or upon that of ſome interfluent ſubtile matter, or ſome other phyſical agent, a ſtrong endeavour to fly off or recede from one another; and that, in divers bodies, the cauſe of this endeavour may act more vigorouſly, than one would eaſily believe: and this ſuffices to ſerve the turn of this diſcourſe; for I preſume, that a perſon of your principles will allow, that local motion muſt be produced by local motion, and conſequently, that, without a very ſtrong, though inviſible and unheeded one, ſuch hard and ſolid bodies, as thick pieces of metal, could not be made to crack.

I know not, whether I may on this occaſion acquaint you with an odd relation I had from a very honeſt and credible, as well as experienced artiſt, whom I, for thoſe reaſons, have ſeveral times made choice to deal with about precious ſtones, and other things belonging to the jewellers and goldſmiths trades. For, conſidering with him one day a large lump of matter, which contained ſeveral ſtones, that he took for coarſe agats, and which were joined together by a cement, that in moſt places was harder, than moſt ordinary ſtones, I perceived, that there remained divers pretty large cavities in this cement, which ſeemed to have contained ſuch ſtones as thoſe, that yet made parts of the lump; upon which occaſion he affirmed to me, that ſeveral of the ſtones grew whilſt they were lodged in thoſe cavities. And when I told him, that though I had been long of an opinion, that ſtones may receive an increment after their firſt formation, yet I did not ſee, how any ſuch thing appeared by thoſe we were looking upon; he gave me in many words an account of his aſſertion, which I reduced to this; that the ſtones he ſpoke of, did, after they were firſt formed, really tend to expand themſelves by virtue of ſome principle of growth, which he could not intelligibly deſcribe; but that theſe ſtones being lodged in a cement extremely hard, and therefore not capable of being forced to give way, their expanſive endeavour was rendered ineffectual, but not deſtroyed: ſo that when afterwards theſe ſtones came to be taken out of the cement, wherein they were bedded, and to whoſe ſides it is like they were not exquiſitely congruous, the compreſſed ſtones, having their ſides now no longer wedged in by the harder cement, quickly expanded themſelves, as if it were by an internal and violently compreſſed ſpring, and would preſently burſt aſunder, ſome into two, and ſome into more pieces; of which he preſented many to his friends, but yet had reſerved ſome, whereof he preſented me one, that I have yet by me, together with ſome of the maſs, whoſe cement I find to bear a better poliſh than marble, and to be very much harder than it. And, in anſwer to ſome queſtions of mine, he told me, that he had taken up theſe ſtones himſelf, naming the place to me, which was not very far off, and that he obſerved all that he told me himſelf, and more than once or twice; and that I needed not ſuſpect, as I ſeemed to do, that it was the ſtrokes employed to force the ſtones out of their beds, that made them break: for, beſides that many of them, which (it ſeems) were not compreſſed enough, did not break, ſeveral of thoſe, that did, were taken out, without offering them any ſuch violence, as that their burſting could with any probability be imputed to it.

CHAP. IX.

OBSERVATION VIII.

One main cauſe, why ſuch motions, as we ſpeak of, are overlooked, is, that we are ſcarce wont to take notice but of thoſe motions of ſolid bodies, wherein one whole body drives away another, or at leaſt knocks viſibly againſt it; whereas many effects proceed from the inteſtine motions produced by the external agent in and among the parts of the ſame body.

THIS obſervation is like to be much more readily underſtood, than granted; and therefore I ſhall offer by way of proof the following experiments.

WE cauſed in a large braſs ſtop-cock the moveable part to be nimbly turned to and fro in the contiguous cavity of that part, that was made to receive it, in that part of the inſtrument, that is wont to be kept fixt. And though this motion of the key were made only by the bare hand, yet in a ſhort time the mutual attrition of the contiguous parts of the inſtrument made ſo briſk an agitation in the other parts, that the incaleſcence made the metal itſelf to ſwell; inſomuch that the key could no more be turned, but remained fixed, as if it had been wedged in; ſo that, to make it work as before, it was neceſſary by cooling it to make it ſhrink a little, and ſo take off the mutual preſſure of the key, and the other part of the ſtop-cock. Nor is this to be looked on as a caſual experiment; for, beſides that it was made more than once, and is very analogous to ſome other trials of mine; I found, that a maker of ſuch inſtruments complained to me, that he was ſeveral times forced to intermit his work, and plunge his inſtrument in cold water, before he could, by grinding, adjuſt the key to the cavity it ought to fit.

I PRESUME I need not take notice to you, that this experiment confirms what I elſewhere mention of the dilatation of metals themſelves by heat; and therefore I proceed to the next inſtance.

THIS is afforded by the known experiment of paſſing one's wetted finger upon the orifice of a drinking-glaſs almoſt filled with water. For, though the eye does not immediately diſcern any motion, that, by reaſon of the preſſure of the finger, is made by one part of the glaſs upon another; yet, that a vibrating motion is thereby produced, may be argued by the dancing of the water, eſpecially that, which is contiguous to the preſſed ſides of the glaſs, by which it is oftentimes ſo agitated, that numerous drops are made to leap quite over, and others are toſſed up to a good height into the air. And that there may be conſiderable motions in the ſides of the glaſs, whilſt it does not break in pieces, we may probably gueſs by this; that in drinking-glaſſes artificially cut by a ſpiral line, both I and others have often found by trial, that a glaſs being dexterouſly inverted and ſhaken, the parts will vibrate up and down ſo manifeſtly, as ſometimes to lengthen the glaſs, by my eſtimate, a quarter of an inch or more; and yet, the glaſs being ſet again upon its foot, it appeared, that it had not been hereby at all injured.

THAT two pieces of iron or ſteel, by being ſtrongly rubbed againſt one another, will at length acquire a temporary heat, is not hard to be believed; but that an edged tool of hardened ſteel ſhould, by having its edge rubbed againſt, have a manifeſt and permanent change made in its texture, you did not perhaps ſuſpect: and yet, having had the curioſity to cauſe ſome metals, and particularly iron and ſteel, to be turned by an excellent artificer; I learned partly by his experience, and partly by my own, that the edge of the ſteel-tool, with which he by degrees ſhaved off the protuberant parts of the metal, would be ſo heated and agitated, that, in no long time, if care were not taken to prevent it, the tool would be brought to look of bluiſh and yellowiſh colours; and, permanently loſing its former temper, would become ſo ſoft, as to be uſeleſs for its former work, unleſs it were again artificially hardened: and therefore, to prevent the trouble of tempering his tools again, this artiſt, from time to time, dipt it, when it began to grow too hot, into a certain liquor, which he affirms, upon much experience, to have a peculiar fitneſs for that purpoſe.

Nor is it always neceſſary, that the body, that makes the parts of an inanimate body work conſiderably on one another, ſhould be either very hard, or impetuouſly moved. For I remember, that having once by me ſome ſhort bars of fine tin, I reſolved to try whether, meerly with my naked hands, (which you know are none of the ſtrongeſt or hardeſt,) I could not procure a conſiderable internal commotion among the parts; and accordingly, laying hold on the two ends of the bar with my two hands, I ſlowly bent the bar towards me and from me two or three times; and having by this means broke or cracked it in the midſt, I perceived, as I expected, that the middle parts had conſiderably heated each other.

What uſe may be made of this experiment, in the ſearch of the hidden cauſe of elaſticity, would be leſs properly conſidered in this place, than in another. But ſince I have named that quality, I ſhall take this riſe to intimate, that if the reſtitution of a ſpringy body, forcibly bent, proceed only (as ſome learned moderns would have it) from the endeavour of the compreſſed parts themſelves to recover their former ſtate, one may not impertinently take notice of the elaſticity, that iron, ſilver and braſs acquire by hammering, among the inſtances, that ſhew, what in ſome caſes may be done by a motion, wherein the parts of the ſame body are, by an almoſt unheeded force, put to act upon one another. But if ſpringineſs depend chiefly upon the pervaſion of a ſubtile matter, as the *Carteſians* would have it, then the inſtances will properly belong to another ſubject.

§ The foregoing examples may alſo ſuffice to make out (what I am unwilling to refer to another head) this ſubordinate obſervation; that men are more uſually, than juſtly, prepoſſeſſed with an opinion, that nothing conſiderable is to be expected from the motion of a body againſt another, unleſs the former do make a manifeſt percuſſion or truſion of the latter. But, becauſe this prepoſſeſſion eſpecially prevails in caſes, where the body, that is by friction or attrition to affect the other, is itſelf ſoft or yielding, I ſhall on this occaſion add a few inſtances to remove this prejudice.

An artiſt, eminent for grinding of optical glaſſes, confeſſed to me, that ſometimes, when he went about to poliſh his broader glaſſes, though but upon a piece of leather ſprinkled with puttee, that friction did ſo heat or otherwiſe agitate the parts of the glaſs, as, to his great loſs, to make it crack from the edge to the middle; which ſeemed the more ſtrange, becauſe we ſee, what intenſe degrees of heat glaſſes will endure without cracking, if the fire be but gradually applied, as this artiſt's glaſſes muſt have been gradually heated.

But I think it worth inquiry, whether in this caſe the whole work be performed by meer heat; and whether there intervene not a peculiar kind of motion, into which ſome bodies are diſpoſed to be put by a peculiar kind of friction, which ſeems fitted to produce in manifeſtly ſpringy bodies, and perhaps in ſome others, (of which divers may be ſpringy, that are not commonly taken to be ſo,) ſuch a vibrating or reciprocal motion, as may have ſome notable effects, that are not wont to be produced by moderate heats, nor always by intenſe ones themſelves. The trembling of the parts of a drinking-glaſs, and the viſible vibration of the long and great ſtrings of a baſe-viol, upon peculiar ſounds, may give ſome countenance to this conjecture; and that in ſome bodies there may be ſuch a tremulous motion produced, by rubbing them upon ſo ſoft a thing as wool, or upon a piece of cloth, I tried by this experiment:

We caſt into a hollow veſſel, very ſmooth within, and of an almoſt hemiſpherical figure, ſeveral ounces of good melted brimſtone; and having ſuffered it to cool, and taken it out, the convex ſurface, as had been deſired, came off well poliſhed: then this conveniently ſhaped lump, which had (if I well remember) four or five inches in diameter, being briſkly rubbed in the ſame line forwards and backwards, upon a cuſhion or ſome ſuch woollen thing, in a place free from other noiſes, I could, by holding my ear to it, and attentively liſtening, plainly hear a crackling noiſe made by the agitated parts, which continued a briſk, and, as I ſuppoſed, a vibrating motion for ſome time after the friction was ended.

That there may be a conſiderable commotion produced among the internal parts of bodies, by rubbing them even againſt ſoft bodies, I have divers times obſerved, by the ſulphureous ſteams, that I could ſmell, if, after having a little rubbed a lump of good ſulphur upon my cloaths, I preſently held it to my noſe: which brings into my mind, that I have had the like effect from much harder and cloſer bodies than ſulphur, when they were rubbed upon bodies, that were ſo too; for having purpoſely taken hard ſtones cut out of men's bladders, and rubbed a couple of them a little againſt one another, they quickly afforded, as I expected, a rank ſmell of ſtale urine.

That diamonds themſelves will, by rubbing upon woollen clothes, be made electrical, ſeems to argue, that even their parts are ſet a moving: and that the commotion reaches to the internal parts, I am the more apt to think, becauſe I have a diamond, that, if I rub it well and luckily againſt my cloaths, will, for a little while, ſhine or glimmer in the dark; which is the ſame phænomenon, that I elſewhere relate myſelf to have produced in the king's larger diamond, by giving it one briſk ſtroke with the point of a bodkin, where the light, that preſently appeared in the gem, ſeemed not referrible to any thing ſo likely, as the ſudden commotion made in the internal parts of that peculiarly conſtituted ſtone.

What a peculiar modification of motion, diſtinct from its degrees of impetus, may do in fluid bodies, we have formerly in this eſſay taken notice of: but, perhaps, it may be worth while to inquire, what kinds there are of it, and what effects they may have in the parts of ſolid bodies themſelves. For I have obſerved, that though thoſe ſtones, that the Italian glaſs-men uſe are very hard, and, if I miſremember not, have ſeveral times afforded me ſparks of fire by colliſion; yet, by rubbing them a little one againſt another, I found, that ſuch an agitation was made in their parts, as to make them throw out ſtore of fœtid exhalations: and it is poſſibly to the ſtony ingredient that glaſs owes the quality I have obſerved in it, and elſewhere mentioned, of emitting offenſive ſteams. And it is remarkable to our preſent purpoſe, that though ſo vehement an agitation of the parts, as is given to glaſs by heat, when it is made almoſt red-hot in the fire, does not make it ſenſibly emit odours; yet barely by dexterouſly rubbing two ſolid pieces of glaſs againſt one another, one may, in a minute of an hour, make thoſe fixed bodies emit ſuch copious ſteams, as I found, not only ſenſibly, but rankly, fœtid; though one would think thoſe ſtinking exhalations very indiſpoſed to be forced off, ſince they were not expelled by the vehement fire, that the glaſs long endured in the furnace, where it was kept melted.

There are few things, that ſhew better, both how the parts of inorganical bodies communicate their vibrating motions to one another, and how briſk thoſe motions are, than that, which happens upon the ſtriking of a large bell with a clapper or a hammer. For though the ſtroke be immediately made but upon one part, yet the motion thereby produced is propagated to the oppoſite, and the ſucceſſive vibrations of the ſmall parts do, even in ſo ſolid and cloſe a body as bell-metal, run many times round; as may appear by the durableneſs of the ringing noiſe, which ſeems plainly to proceed from the circularly ſucceſſive vibrations of the parts, which, unleſs they briſkly tremble themſelves, can ſcarcely be conceived to be fitted to give the air that tremulous motion, whoſe effect on the ear, when the firſt and loud noiſe made by the percuſſion is paſt, we call ringing. And this motion of the parts of the ſounding bell may be further argued by this; that if the finger, or ſome other ſoft body, be laid upon it, the ſound will be checked or deaded, and much more, if a broad ſtring, though of a ſoft ſubſtance, be tied about it. And not only an attentive ear may often make us gueſs, that the ringing ſound is produced by a motion propagated circularly in the bell, but this vibrating motion may ſometimes be alſo felt by the tremulous motion communicated by the trembling parts of the bell to the finger, that is warily applied to it. That this motion paſſes in a round from one ſide of the bell to the other, ſeems manifeſt by the great difference of ſound, eſpecially in regard of ringing, that may be obſerved in a ſound bell, and in a cracked one; where yet all the matter and the former figure are preſerved, only the intireneſs or continuity, which is neceſſary to the circulation (if I may ſo call it) of the tremulous motion, is at the crack ſtopt or hindered. And that the motion of the parts is very briſk, may be gueſſed partly by what has been ſaid already; but much more, if that be true, which, not only is traditionally reported by many, but has been affirmed to me by ſeveral artificers, that deal in bells, who averred, as an experienced thing, that if a conveniently ſized bell were bound about, any thing hard, with a broad ſtring, and then ſtruck with the uſual force, that it would otherwiſe bear very well; that percuſſion would break it, giving a diſorderly check to the briſk motion of the parts of the bell, whereof ſome happening to be much more (and otherwiſe) agitated than others, the force of their motion ſurmounts that of their coheſion, and ſo produces a crack.

But, in regard great bells are not eaſy to be procured, nor to be managed, when one has acceſs to them, I ſhall add, that I took the bell of a large watch, or very ſmall clock, made of fine bell-metal, which had no handle or other thing put to it, ſave a little bodkin or ſkewer of wood, whoſe point we thruſt into the hole, that is uſually left in the middle of the baſis; and this ſharp piece of wood ſerving for a handle to keep the bell ſteady enough, we placed in the cavity of it, near the edges, (for that circumſtance muſt not be omitted,) ſome black mineral ſand, or, in want of that, ſome ſmall filings of ſteel or copper, or ſome other ſuch minute and ſolid powder, which yet muſt not be too ſmall; and then ſtriking moderately with the key againſt the ſide of the bell, we obſerved, (as we expected,) that, whilſt it continued briſkly ringing, it made many of the filings to dance up and down, and ſometimes to leap up, almoſt like the drops of water formerly mentioned to ſkip when the brim of the glaſs was circularly preſſed by the wetted finger: which prompts me to add, that, having put a middle-ſized drop of water (for in this caſe the quantity is a conſiderable circumſtance) near the lower edge of the bell, it was eaſy to make it viſibly tremble, and be, as it were, covered over with little waves, by a ſomewhat briſk ſtroke of the key on the oppoſite ſide. And this effect was more conſpicuous, when a very large drop of water was placed near the edge on the convex ſide of a hand-bell, whoſe clapper was kept from any where touching the inſide of it. And to obviate their jealouſy, that, not having ſeen the manner of the above-mentioned motion of the ſand, might ſuſpect, that it was produced by the impulſe, which the bell, as an intire body, received from the percuſſion made by the key, we ſeveral times forbore putting in the filings, till after the ſtroke had been given; which ſatisfied the ſpectators, that the dancing and leaping of the minute bodies proceeded from the ſame briſk vibrations of the ſmall parts of the bell, which, at the ſame time ſtriking alſo the air, produced a ringing ſound, which might very well, as it did, out-laſt the ſkipping of the filings; the exceedingly minute particles of the air being much more eaſily agitable, than the comparative groſs and heavy corpuſcles of the powder. And this ſucceſs our experiment had in a bell, that little exceeded an inch and half in diameter.

And here, *Pyrophilus*, I ſhall put an end to this rhapſody of obſervations, hoping, that among ſo many of them, ſome or other will be able to engage you, if not to conclude, yet at leaſt to ſuſpect, that ſuch local motions, as are wont either to be paſt by unobſerved, or be thought not worth the obſerving, may have a notable operation, though not upon the generality of bodies, yet upon ſuch as are peculiarly diſpoſed to admit it, and ſo may have a conſiderable ſhare in the production of divers difficult phænomena of nature, that are wont to be referred to leſs genuine, as well as leſs intelligible cauſes.

A SHORT
SUPPLEMENT
TO THE
ESSAY
OF THE
GREAT EFFECTS
Of even LANGUID and UNHEEDED
LOCAL MOTION.

THAT I may not be altogether wanting to the expectation, that may have been raiſed by a paſſage in the advertiſement prefixed to the foregoing eſſay, I ſhall here ſubjoin ſome particulars, which perhaps will not be unwelcome to the readers, that occurred to my remembrance, whilſt I was, with a tranſient eye, reviewing the heads of the paſt diſcourſe: but theſe paralipomena or ſupplements will be but few, not only becauſe of my want of leiſure to review the tract they belong to deliberately, but alſo becauſe ſome inſtances, that might be here ſubjoined, may be more opportunely brought in in other papers.

To the third CHAPTER.

THAT the motion of the air, that accompanies ſounds, may be propagated to great diſtances, and yet make conſiderable impreſſions on the bodies it finds there diſpoſed to admit its action, may be notably confirmed by a phænomen I have met with in the learned mathematician *Borellus*, who relates it upon his own knowledge, and not undeſervedly magnifies it; which I ſhall therefore recite in his own words. *Aderam* (ſays he) *Tauromenii Siciliæ, quando Ætna mons eruptionem quandam effecerat propè Ennam, urbem fere* 30. *milliaria à Tauromenio diſtantem, tunc vicibus interpolatis eruptiones ingentes ignis vorago efficiebat, grandi ſono & ſtrepitu, & tunc omnia Tauromenii ædificia tremore concutiebantur, in quo circumſtantiam notatu digniſſimam obſervavi; ſcilicet, quòd domus & ædificia, quæ directè expoſita erant proſpectui ejuſdem voraginis, vehementiſſimè concutiebantur; reliquæ verò domus, quæ conſpectu voraginis privabantur, ſatis lentè & leniter tremorem efficiebant.* Upon which matter of fact he thus argues: *Profectò, ſi hujuſmodi tremor*

Borellus *de vi Percuſſionis. Prop.* CXI.

factus fuiſſet à concuſſione et reſilitione ſoli Taurominitani, omnes domus æquè concuſſæ fuiſſent, et æquali tremore agitatæ, ita ut non poſſit conſpectus voraginis tam inſignem et evidentem inæqualitatem tremoris procreare; *igitur neceſſariò à tremore ejuſdem aëris incuſſo in parietibus domorum liberè percuſſiones excipientum, agitatio illa efficiebatur. Videas hinc*, (infers he) *quanta ſoni ad* 30 *milliarium diſtantiam efficacia ſit*. “ *Borel. de vi percuſſionis prop.* CXI. has theſe obſervable words: “ I was at *Tauromenium* in *Sicily*, when the “ mountain of *Ætna* broke out near *Enna*, “ a town diſtant about thirty miles from “ *Tauromenium*; whilſt the gap did ſend out “ now and then, with a great noiſe, fire “ and flame, all the houſes of *Tauromenium* “ were ſenſible ſhaken; and it was obſervable “ that ſuch houſes, as looked directly towards the gap, were moſt of all agitated; “ thoſe that looked otherwiſe ſhaking more “ ſlowly. Upon which matter of fact he argues thus: had this trembling been occaſioned by the ſhaking of the ground of “ *Tauromenium*, all the houſes had been “ equally ſhaken, ſince this inequality of “ motion could not be aſcribed to their different ſituation: hence then we muſt “ needs conclude, that this agitation was produced by the impreſſion of the air upon “ the walls of the houſes, which demonſtrates to us the great efficacy of a ſound, “ though at thirty miles diſtance.”

To the fifth Chapter.

THAT motion may be propagated far, through bodies of differing natures, may be inferred from what is mentioned in this chapter, eſpecially about earthquakes: but becauſe it may reaſonably be ſuſpected, that the active matter, which produces thoſe ſtupendous motions, is diſperſed into divers places, and may be of conſiderable extent; I ſhall here ſubjoin, out of the eloquent *Famianus Strada*, an inſtance, which is much the moſt memorable to my purpoſe, that I remember to have met with in hiſtory, to manifeſt to how great an extent a motion excited in a very narrow compaſs, perhaps but a very few fathom ſquare, may be propagated through differing mediums, and one of them as ſolid as earth. This famous hiſtorian then having deſcribed a ſtupendous work, that had been with great ſkill and care made by the prince of *Parma*, to keep the city of *Antwerp*, which he cloſely beſieged, from being relieved by the river *Scheldt*, (which, though not broad, is deep) proceeds to relate, that an engineer, who was a great maſter in his art, having undertaken to deſtroy this great work with a veſſel (which I think we may call a floating mine) fraught with gunpowder, fireworks, *&c.* performed it with ſo tragical a ſucceſs, that ſome Spaniſh officers, that were preſent, reckoned eight hundred to have been killed outright, beſides a great number, that were wounded and maimed. But that part of the narrative, which comes home to our preſent purpoſe, is delivered in theſe words:

On a ſudden the fatal ſhip burſt, with ſuch a horrid craſh, as if the very ſky had rent aſunder, Heaven and Earth had charged one another, and the whole machine of the earth itſelf had quaked: for the ſtorm of ſtones, chains and bullets being caſt out with thunder and lightning, there followed ſuch a ſlaughter, as no man, but that actually it happened, could have imagined. The caſtle, on which the infernal ſhip fell, the pile-work of the bridge to *St. Mary*'s fort, that part of the naval bridge next the caſtle, ſoldiers, mariners, commanders, a great number of cannons, armour and arms; all theſe this furious whirlwind ſwept away together, toſſed in the air, and diſperſed as wind doth leaves of trees. The *Scheldt*, prodigiouſly gaping, was firſt ſeen to diſcover its bottom, then ſwelling above the banks, was even with the rampiers, and overflowed *St. Mary*'s fort above a foot. The motion of the panting earth [*N. B.*] extended its force and fear above nine miles. [If he means the miles of that country, or Dutch leagues, they amount to thirty-ſix Engliſh miles.] There we found ſtones, and that very great ones, as grave-ſtones, and the like, a mile off the river, ſtruck into the ground, in ſome places, four palms.

Famian. Strad. *de Bello Belg.* Dec. 2. *lib.* 6.

To the ſixth Chapter.

Observation. I.

WHAT is delivered in this chapter about the operation of ſounds and animals, particularly that which is mentioned (p. 264.) about the effect of muſick upon ſerpents at *Grand Cairo*, may be not only confirmed, but exceeded by a ſtrange relation, that I had from a perſon of unſuſpected credit; which narrative having appeared to me ſo conſiderable, as well to deſerve a place among my *Adverſaria*, I ſhall ſubjoin that part of it, which concerns our preſent ſubject, in the words, wherein I find it ſet down.

Sir *J. C.* a very candid and judicious traveller, favouring me yeſterday with a viſit, told me, among other remarkable things relating to the *Eaſt Indies*, (which countries he had curiouſly viſited) that he, with divers European merchants had ſeen, (and that, if I miſtake not, ſeveral times), an Indian, who, by many, was thought to be a magician, that kept tame ſerpents of a great bulk; and that when the owner of them played upon a muſical inſtrument, theſe ſerpents would raiſe themſelves upright into the air, leaving upon the ground but three or four inches of their tail, upon which they leaned for their ſupport. He added, that at the ſame time, that they erected their bodies, they alſo ſtretched and lengthened them in a ſtrange and frightful manner; and whilſt they were thus ſlender, they were taller than he, or any man of ordinary ſtature. But that, which appeared to him the moſt wonderful and ſurpriſing, was, that they manifeſtly ſeemed to be very much affected with the muſick they heard; inſomuch that ſome parts of the tune would make them move to and fro with a ſurpriſing agility, and ſome other parts of it would caſt them into a poſture, wherein they ſeemed to be half aſleep, and, as it were, to melt away with pleaſure.

To the ſixth Chapter, p. 264.

Observation II.

BEcauſe the truth, even of the principal effects of the biting of the tarantula, has of late been publickly called in queſtion, I was glad to meet with an ingenious traveller, that in *Calabria* or *Apulia* was himſelf bitten by one of thoſe venomous inſects; and though it were but ſlightly, yet the effects he felt in his own body, and thoſe greater ones he ſaw produced in other perſons, that were more unhappily bitten, brought credit to the main of what ſober writers affirm of the ſymptoms and cure of that poiſon. And the learned, *&c.*

To the ſeventh Chapter, p. 265.

MUCH of what is delivered in this chapter, and elſewhere, about the operation of air or inviſible fluids (whoſe motions affect not the touch) upon congruous ſolids, may be confirmed by that notable experiment, which has been publiſhed in an elegant diſcourſe by the learned *Morhoſius*; about a Dutch wine-ſeller in *Amſterdam*, by name *Nicolaus Petterus*, who having found the tone or note peculiarly belonging to a large bellyed drinking-glaſs, ſuch as the Dutch call Romer, and many here call Rheniſh wine-glaſſes, would, by accommodating his voice exactly to that tone, and yet making it loud and laſting, make the veſſel, though not viſibly touched, firſt tremble and then burſt; which it would not do, if the voice were, though but a little, too low or too high. This notable experiment has been ſeen by many virtuoſi, both before and ſince he publiſhed it. And the very ingenious writer, as he paſſed through *London*, not only related it to me, but very civilly offered me farther ſatisfaction, if I could furniſh him with a Romer, which I was very ſorry, that where we then were, was not to be procured.

To the eighth Chapter.

Observation I.

IT may add probability to ſome things delivered in this chapter, and in divers other paſſages of this treatiſe, if I here recount a ſtrange phænomenon, that came into my memory, whilſt I was running over thoſe parts of this diſcourſe.

The phænomenon, in ſhort, was this: having met with divers pieces of tranſparent glaſs, which I had reaſon to think to be of a texture or temper very differing from ordinary glaſs, I thought fit to try, whether ſome of them were not far more ſpringy and brittle than their thickneſs would make one expect. And accordingly, though I found ſeveral, wherein the experiment would not ſucceed, eſpecially if their figure were not convenient; yet with ſome others I had very good ſucceſs, and particularly with ſome, that were ſhaped almoſt like the ſharper end of the neck of a retort: for though theſe pieces of glaſs were much thicker than ſuch necks are wont to be, being perhaps ſix or ſeven times as thick, as common drinking-glaſſes; yet I more than once made the trial ſucceed ſo well, that, by obliquely ſcratching them, or tickling them, if I may ſo ſpeak, on the inſide with the head or point of a pin, they would forcibly burſt into many pieces in my hand. In which ſurpriſing phænomenon, the matter of the glaſs ſeemed to contribute ſomething to this odd effect of ſo languid a motion, but much leſs than the texture, or tenſion, it obtained by the peculiar way of ordering it in the fire and the air.

To the eighth Chapter.

Observation II.

TO ſhew, that the ſuſpicion I mention myſelf, a little before the end of this chapter, to have had, that the breaking of the ſtones there ſpoken of might poſſibly be produced or promoted by ſome impreſſions, remaining after the ſtrokes employed to force the ſtones of their beds, was not altogether without ground;

I shall here obſerve, that it need not ſeem incredible, that faint ſtrokes and attritions may leave more laſting and operative motions among the inſenſible parts, even of compact and ſolid bodies, than one would readily imagine: for I have ſeveral times found, ſometimes by obſervations deſignedly made, and ſometimes by undeſigned accidents, that, having cauſed ſomewhat thin veſſels of glaſs, eſpecially urinals, to be diligently made clean with ſand mixed with water, to looſen or grate off the foulneſs, that adhered to the ſides of the veſſel; though the veſſels, after having been thus made clean, did not appear to have received the leaſt injury, and would continue very intire perhaps for ſeveral hours, yet after that time they would, of themſelves, break with noiſe, and thereby become unſerviceable for the future. But though this happened to many urinals, yet becauſe to more others it did not, it ſeemed probable, that the diſſilition depended chiefly upon the peculiar texture of the glaſs in this or that veſſel;

veſſel, whether acquired by a mixture of the ingredients, that was not uniform enough, or made in a due proportion, or elſe by the too haſty refrigeration of the veſſel, eſpecially if it chanced, as is not very unuſual, to be cooled more haſtily in one part than another.

To the ninth CHAPTER, p. 269.

OBSERVATION I.

BEcauſe there are divers gems, particularly thoſe tranſparent ones, that are red or blue, that are much harder than iron or ſteel, it may much ſtrengthen the proof of our eighth obſervation, if I here relate, that a jeweller to a great princeſs anſwered me, that when he poliſhed ſapphirs, rubies, and ſome ſorts of other hard gems, upon his mill, they would ſeem, when attrition had made them very hot, to be all on fire, like ſo many little coals; and that each of them had the light it afforded tinged with a colour proper to the ſtone; ſo that the ruby gave a red light, the ſapphir a blue, *&c.* And I remember, that inquiring of a ſkilful cutter of diamonds and poliſher of gems, whoſe cuſtomer I had been, about ſome conjectures I had concerning things belonging to his profeſſion, he anſwered me, that ſometimes, when he poliſhed certain ſtones, eſpecially rubies, that were pretty large and perhaps not thick, he could plainly perceive, that the ſtone gaped at and near the edge, as if it were begun to be cracked; which ſign admoniſhed him to make haſte to ſlacken the motion of the mill, leſt the ſtone ſhould abſolutely burſt; which if it did not, he could not perceive any flaw in it, when it was throughly cold; but, which was ſtrange, it appeared as entire as ever. He added, in confirmation of what he had ſaid of the intenſe heat, that gems would ſometimes acquire by attrition, whilſt they were in poliſhing, that having lately given by this means too great a degree of heat to an oriental topaz, (which ſort of that gem is very hard,) it cracked upon the mill, inſomuch that one part of it quite ſeparated from the reſt, and ſpoiled the ſtone in the capacity of a gem; as a proof whereof he had laid it aſide for me, and would needs make me accept it as a curious, though not an uſeful, thing.

To the nineteenth CHAPTER.

OBSERVATION II.

TO confirm, what has been ſaid in the eighth obſervation to ſhew, that ſlow and inſenſible inteſtine motions of the parts of a body, that ſeem quieſcent, may be very operative, chance afforded me a notable inſtance, which was this. I had, to preſerve a liquor, from which I expected a curious experiment, incloſed it in a ſtrong vial, to whoſe neck a thick glaſs ſtopple was but too exquiſitely adapted. This veſſel I ſet upon the edge of a window, in a high and ſecure place, that it might not be moved. There it continued many months, or, if I miſremember not, above a year; and the liquor was of ſuch a nature, that if any body had, though but for a few moments, taken out the ſtopple, I could eaſily diſcover it. But, after all this while, one day, that I was ſitting in my cloſet, at a good diſtance from the place, in which the vial ſtood, I heard a loud and briſk noiſe, almoſt like the report of a piſtol, and then perceived, that ſomething came rolling to my feet: I haſtily took it up, and found it to be the thicker and larger part of the ſtopple of my vial, which of itſelf had flown off, leaving the remaining part ſo cloſely and ſtrongly adjuſted to the neck, which ſerved it for a kind of ſocket, that I could by no means pull it out thence. At this accident I was not a little ſurprized, conſidering the thickneſs of the ſolid glaſs, and that it had ſtood ſo long unmoved, and that the bigger and heavier part of the ſtopple broke off from the other with ſuch violence, and was carried from it by inviſible motors to ſo great a diſtance: which ſeemed the more ſtrange, becauſe there was no ſhaking nor treading in the room, that could put the parts of the glaſs into motion, there being no body preſent but myſelf, who was ſitting quietly and ſtudying.

To the ninth CHAPTER.

OBSERVATION III.

TO confirm what I have in the eighth obſervation and elſewhere delivered about the latent motion of parts, that may be in a body not only quieſcent but ſolid, I ſhall here add a ſtrange inſtance, which was afforded me by a diamond, belonging to an ingenious merchant of that ſort of gems, who brought many fine ones out of the *Eaſt-Indies*. For having, at the diamond-mine itſelf, purchaſed, amongſt other ſtones, that grew there, a rough diamond, that he valued at about a hundred pounds, and had well conſidered when he bought it; coming to look over his purchaſe again once more, about ten days or a fortnight after, he was much ſurprized to find, to his great loſs, that this diamond had of itſelf cracked in ſeveral places, and ſo became of little or no value, but as it was a rarity: and indeed I could not without wonder ſee ſo fair and hard a ſtone ſo oddly ſpoiled with clefts, that ſeemed to penetrate ſo very deep, that it was gueſſed it would not be very difficult to pull the parts of the ſtone aſunder. And on this occaſion he told me, that he had admired this accident at firſt, much more than he did afterwards; for complaining of it to divers merchants and jewellers, that he met with in thoſe parts; he was told, that though it ſeldom happen, yet it was no ſuch wonderful accident, the like misfortune having befallen others as well as him.

AN
EXPERIMENTAL DISCOURSE
Of ſome UNHEEDED
CAUSES
OF THE
INSALUBRITY and SALUBRITY of the AIR,
BEING
A Part of an intended NATURAL HISTORY of AIR.

The PREFACE.

HAVING heretofore had occaſion to draw together, under certain heads, divers unpubliſhed obſervations and experiments of my own, and ſome of other men by way of memorials for a natural hiſtory of the air; I thought fit, by more largely treating of two or three of the ſubjects diſtinctly mentioned in my ſcheme of titles, to give a ſamplar or ſpecimen of what may be done upon the other heads of the deſigned hiſtory. Upon this account I treated ſomewhat largely of the ſalubrity and inſalubrity of the air, as a ſubject, which for the importance of it to men's healths and lives, I thought deſerved to be attentively conſidered, and have its cauſes diligently inquired into. And having obſerved, that among the ſix principal cauſes of the healthfulneſs and inſalubrity of the air; namely, the climate, the ſoil, the ſituation of the place, the ſeaſons of the year, the reigning winds and contingencies (whether more or leſs frequent) and eſpecially ſubterraneal ſteams: having I ſay obſerved, that among theſe cauſes there was one, *viz.* the laſt named, about which I thought I could offer ſomething, that I had not met with in the books of phyſicians, that treat of it; I was thereby invited to ſet down my thoughts and obſervations by way of conjectures, which I was made to believe would appear uncommon, and would not prove uſeleſs. Theſe obſervations and reflexions I referred, for clearneſs and diſtinction's ſake, to four propoſitions: but when I had gone thorough the three firſt, and made ſome progreſs in the fourth, being hindered by divers avocations to make an end of it, I laid by the whole diſcourſe in a place, which I thought a ſafe one; but when afterwards I had ſome opportunity to diſpatch what remained, I found all the diligence I uſed to retrieve the entire manuſcript unſucceſsful. At this ſurprizing accident I confeſs I was ſomewhat troubled; becauſe, whatever may be thought of the diſcurſive part of thoſe papers, the hiſtorical part contained divers matters of fact, that I did not meet with in books, nor can now diſtinctly remember, and will not perhaps be lighted on by even phyſicians, or ſuch naturaliſts, as derive their knowledge only from them. It is upon this conſideration, that having afterwards met with many papers, that belonged to moſt parts of the unhappy diſcourſe, I thought fit to put them together in the beſt order I could, that I might not loſe what might give ſome light to ſo important a ſubject as the theory of diſeaſes. And this courſe I the rather pitched upon, becauſe, before the papers about the ſalubrity of the air, I miſſed two other of my manuſcripts, whereof the former contained a collection of medicinal things, and the ſecond a defence of the mechanical way of philoſophizing about natural things, as it reſpects religion. And I remembered, that having formerly loſt a manuſcript I was much concerned for, I purpoſely made a noiſe of it; whence I ſuppoſed the plagiary would conclude himſelf unable to make it paſs for his: and in effect the book was in a while after privately brought back; ſo that I found it laid in a by-place, where I had before as fruitleſly as carefully ſought it.

AN

An Experimental Discourse of ſome unheeded Causes of the Insalubrity and Salubrity of the AIR, &c.

THE ſixth and laſt thing, upon which the ſalubrity and inſalubrity of the air depends, is the impregnation it receives from ſubterraneal effluvia. And though this be a cauſe not wont to be much heeded by phyſicians themſelves; yet I take it to be oftentimes one of the moſt conſiderable in its effects.

The effluvia, that paſs into the air, may be diſtinguiſhed into ſeveral ſorts, according to their reſpective natures, as has been elſewhere ſhewn: wherefore I ſhall now only take notice of the differences, that may be taken from place and time; upon which account we may conſider, that ſome of them ariſe from the cruſt (if I may ſo call it) or more ſuperficial parts of the earth; and others have a deeper original, aſcending out of the lower parts, and, as it were, bowels of the terraqueous globe. And to this difference taken from place I muſt add another, perhaps no leſs conſiderable, afforded by time; which difference relates chiefly to the ſecond ſort of ſteams newly mentioned.

Of the ſubterraneal effluvia, ſome are almoſt conſtantly or daily ſent up into the air, and thoſe I therefore call ordinary emiſſions; and others aſcend into the air but at times, which are not ſeldom diſtant enough from one another, and thoſe I call extraordinary emiſſions; whether they come at ſtated times, and ſo deſerve the title of periodical, or elſe uncertainly, ſometimes with far greater, ſometimes with far ſmaller intervals, and ſo may be called fortuitous or irregular. But though I thought it might render what I am about to ſay more clear, if I made and premiſed the two foregoing diſtinctions, yet becauſe in many caſes nature does not appear ſollicitous to obſerve them, but at the ſame time imbues the air with ſteams referrible to divers members of theſe diſtinctions; I ſhall ſeveral times, though not always, take the liberty to imitate her, and conſider the effluvia of the terraqueous globe in the more general notion, that they are ſo.

I know it is frequently obſerved, and uſually granted, that marriſh grounds and wet ſoils are wont to be unhealthful, becauſe of the moiſt and crude vapours, that the ſtagnating waters ſend up too copiouſly into the air. And on the other ſide, dry ſoils are, becauſe of their being ſuch, generally looked upon as healthy. Nor do I deny, that theſe obſervations do moſt commonly hold true. But yet I think, that beſides what can be juſtly aſcribed to the moiſt vapours, or dry exhalations, we have been ſpeaking of; in many places the healthfulneſs and inſalubrity of the air may be aſcribed to other ſorts of effluvia from the ſoil, than thoſe, that act merely, or perhaps principally, as theſe are either moiſt or dry.

Proposition I.

To deliver my thoughts about this matter ſomewhat more diſtinctly, I ſhall lay them down in the four enſuing obſervations or propoſitions, whereof the firſt ſhall be this: It ſeems probable, that in divers places the ſalubrity or inſalubrity of the air, conſidered in the general, may be in good part due to ſubterraneal expirations, eſpecially to thoſe, that I lately called ordinary emiſſions. For in ſome places the air is obſerved to be much more healthy, than the manifeſt qualities of it would make one expect: and in divers of theſe caſes I ſee no cauſe, to which ſuch a happy conſtitution may more probably be aſcribed, than to friendly effluvia ſent up from the ſoil into the air; which particles, either by promoting tranſpiration (that great inſtrument of health and recovery;) or by hindering the production, or checking the activity, of morbific ferments; or by mortifying or diſabling ſome noxious particles, that would otherwiſe infeſt the air; or by other ways, that I ſhall not now ſtay to enumerate; may not a little contribute to keep the bodies of thoſe, that live in that air, in that regular and deſirable ſtate we call health. I know indeed, that it is generally thought, and often true, that mineral bodies do ſend up exhalations, hurtful not only to plants, but to men; but when we mean ſubterraneal things indefinitely, though men are wont to look upon them but ſlightly under a general confuſed notion, we employ a word more comprehenſive, than moſt men are aware of, there being a great variety, as well as multitude of bodies, that nature has lodged in her dark ſtore-houſes under the ſurface of the earth: and of theſe differing ſorts of bodies, though it is probable, that the greateſt part are ſuch, whoſe effluvia are unhealthful to men, yet there may be others, whoſe emanations may be friendly to him. I have known it obſerved, that over ſome tin-mines in the weſtern parts of *England*, not only trees, but far more tender plants, as graſs, are wont to proſper and flouriſh; and (if I much miſremember not) I have ſeen verdant trees growing juſt over a vein of another ſort of mineral, that lay near the ſurface of the earth: and it is likewiſe obſervable about thoſe, that conſtantly dig in thoſe tin-mines, that they do not lead a ſhort and ſickly life, as in many others, but arrive at a great and vigorous age. And an ancient poſſeſſor of ſome of theſe mines being aſked by me, whether amongſt the otherwiſe differing exhalations, that aſcended into the air, he did not find a difference as to ſmell, bad or good; he anſwered, that though moſt of thoſe viſible fumes had a ſmell, that participated enough of ſulphur or bitumen to be offenſive, yet ſome others were ſo far from being ungrateful, that they were well ſcented. And, on this occaſion, I remember, that not long ſince a friend of mine and another virtuoſo being partners in a chargeable attempt to diſcover a mine, in digging deep for it, they accidentally broke into a vaſt ſubterraneal cavern, into which becauſe the diggers would not venture to deſcend, one of theſe curious gentlemen cauſed himſelf to be let down, and there found the air very temperate and refreſhing, and that he long breathed it with delight; and on the floor, or ſoil (which reached farther than he could diſcover) he found many and various minerals, moſt of them embryonated, or imperfectly formed, and ſtore of a kind of mineral earth, whoſe ſmell was fragrant and very pleaſant, both in his judgment, and that of ſome ladies. And though, when ſome of thoſe minerals were brought to me, a ſmall lump of this earth, that was among them, had been kept ſo long in the air, as to ſpend moſt of its odoriferous particles, yet the ſmell it ſtill retained was, though but faint, yet pleaſing.

THAT from foſſiles, that lie hid under the ſurface of the earth, and have a conſiderably large ſpread, there may aſcend ſtore of wholeſome effluvia into the air, ſeemed to me the more probable by what I noted at my laſt being in *Ireland*; where, being invited by a brother of mine to paſs ſome time in a country houſe of his, to which there belonged a very large ſheep-walk, that produced ſhort, but excellent graſs; I learned (and was eaſily perſuaded by ſome things I took notice of) that this place was juſtly reputed very healthful: and this ſalubrity of the air, together with the ſweetneſs of the graſs, ſome circumſtances invited me to aſcribe to this; that the ſoil was ſuſtained by a large tract of limeſtone, which I ſuppoſed to emit continual exhalations into the air; which conjecture will perhaps with the leſs ſcruple be aſſented to, if I add, that it has been long and generally obſerved, that, as far as the limeſtone extends, that tract of ground makes the ſnow, that falls on it, thaw or melt much ſooner, than it does on the neighbouring lands.

AFTER I had made this obſervation, I mentioned it in diſcourſe to an inquiſitive perſon, that had ſeen and been employed about ſeveral mines; and I aſked him, whether he had met with any thing of this kind: to which he anſwered me, that in *Derbyſhire*, at a place, which he named to me, he and others had obſerved, that a large tract of limeſtone land was ſo warm (as they ſpeak) as to diſſolve the ſnow, that fell on it, very much ſooner, than another great ſcope of land, which was divided from it but by a glin, where the ſoil did not cover limeſtone, but freeſtone.

AFTERWARDS diſcourſing of this ſubject with an ingenious perſon, that had viſited the Hungarian and Bohemian mines; he told me, that during his ſtay among the former, he often walked abroad with the overſeer of them, a famous and experienced mineraliſt, who delighted to breathe the freſh morning air upon ſome hills abounding with minerals; that his guide made him obſerve, that when they were over a tract of land, that afforded much of that noble ore (which by a German name he called *Rot-gulden ertz*) he found the ſmell to be pleaſing, and the air refreſhing: and whereas, in paſſing over ſome mines, he found himſelf moleſted by offenſive fumes, he felt no ſuch effect, when he was upon that ſcope of ground, under which there lay veins of cinnabar, or, if you pleaſe, a mine of quick-ſilver ore: and his antient guide told him, that next the *Rot-gulden ertz* before-mentioned, the ſoil containing theſe cinnabarine veins, was that, whoſe incumbent air was the moſt eligible for pleaſantneſs and ſalubrity. And I the leſs wonder, that in ſome places the ſubjacent foſſiles ſhould impregnate the air with wholeſome effluvia, becauſe I remember I had the curioſity to ride many miles, (though in the depth of winter,) to ſee a ſcope of ground, that was famous for a good pottery; where, beſides many other mineral earths, that I took notice of, there was a pit or groove, that reached, if I miſtake not, fifteen or twenty foot beneath the ſurface of the ground; whence they dug up a kind of white clay ſo richly impregnated with ſubtile and noble parts, that it afforded a chymiſt or two of my acquaintance (for I had myſelf no opportunity to diſtill it) good ſtore of a ſubtile ſpirit of a volatile and ſaline nature, which, upon trial, they highly extolled for its cordial and other virtues in phyſic; and which, by ſome peculiar mechanical trials I made with it, I concluded to abound with a volatile ſalt, not unlike that of urine or hartſhorn. And ſince by this inſtance we ſee, that ſome unſuſpected foſſiles may be enriched with medicinal and fugitive ſalts and ſpirits; it may reaſonably be ſuppoſed, that theſe aſcending into the incumbent air may highly conduce to the ſalubrity of it. And the curioſity I have had to examine chymically ſome boles, and other bodies, which are wont to be unregardedly comprized under the confuſed notion of earths, makes me ſuſpect, that there may be far more ſpecies of ſalubrious foſſiles, than many have yet taken notice of.

BUT peradventure you will much the more eaſily admit in general, that ſubterraneal tracts of great extent may for a very long time ſend up into the air copious expirations, not diſcernible by any of our ſenſes, nor commonly ſuſpected to be found in that body, if you pleaſe to conſider with me (what I do not remember to have been taken notice of to this purpoſe) that the common air we live in, and breathe, does always abound, and for many ages has been impregnated, with the copious magnetical effluvia of the earth; which our induſtrious *Gilbert*, and after him ſome learned Jeſuits and others, have proved to be a great, though faint magnet; and whoſe emanations, as they conſtantly ſtream through the air, I have elſewhere by particular experiments ſhewn to be capable of paſſing through the pores of glaſs itſelf, and acting almoſt inſtantaneouſly, and yet manifeſtly, upon bodies hermetically ſealed up in it. But though from what has been ſaid it may be inferred, that it is not improbable the ſalubrity of the air in ſome places may be chiefly, or at leaſt in part, due to the wholeſome expirations of ſubterraneal bodies; yet, generally ſpeaking, the air is depraved, in far more places than it is improved, by being impregnated with mineral expirations. And indeed, beſides that among the minerals known unto us, there are many more that are noxious, than that are wholeſome; the power of the former to do miſchief is wont to be far more efficacious, than that of the latter to do good; as we may gueſs by the ſmall benefit men receive in point of health by the effluvia of any mineral, or other foſſile, known unto us, in compariſon of the great and ſudden miſchief, that is often done by the expirations of orpiment, ſandarach, and white arſenick; for though that ſold in ſhops is factitious, being made of orpiment ſublimed with ſalt, yet it is found natural in ſome Hungarian and other mines. On which occaſion I remember, that the ingenious perſon lately mentioned to have with his guide taken the air upon the hills of that mineral country, anſwered me, that, when his guide and he walked over ſome veins of theſe noxious minerals, he met with ſeveral odorous ſteams, which, though differing from one another, agreed in this, that they were all offenſive to him; and particularly ſome of them by their unwelcome ſharpneſs, and others by giving him a troubleſome difficulty of reſpiration. I will not here urge thoſe ſulphureous ſteams, that ſo ſuddenly deprive dogs of ſenſe and motion, in the neapolitan *Grotta di Cani*; becauſe there the exhalations are too much included, and, as it were, pent up: but it is very proper to alledge for my preſent purpoſe the *Aorni* or *Averni*, which are mentioned by good authors to be found, ſome in *Hungary*, and ſome in other countries; for in theſe places there aſcend out of the earth ſuch noxious and plentiful exhalations, as kill thoſe animals, that draw in the air they infect; and ſome of them are able to precipitate even the birds, that fly over the caverns, that emit them. But there are a multitude of places, where it is not ſo manifeſt, that hurtful exhalations aſcend into the air, and yet they really do ſo; there being in many places whole tracts of land, that near the ſurface of the earth abound with marchaſitical minerals, as theſe do with a ſharp vitriolate ſalt, which, together with the ill conditioned ſulphur, that they alſo plentifully contain, aſcend into the air, and render it corroſive. On which occaſion I remember, that, for curioſity's ſake, I took ſome Engliſh ſhining marchaſite, and cauſed a pound of it to be diſtilled in an earthen veſſel with a good fire; by which means, notwithſtanding its dryneſs, I obtained two or three ſpoonfuls of a limpid liquor, that ſmelled very ſtrongly, like that, which the Helmontians call *gas ſulphuris*; and which appeared manifeſtly to be of an acid nature, both by the taſte, and by it's readily corroding and diſſolving unbeaten coral, even in the cold, to mention here no other tryals, that I made with it. And the mineral afforded me, together with this liquor, about an ounce and three quarters of inflammable ſulphur, part whereof aſcending (as may be gueſſed) in the form of very agile corpuſcles, theſe faſten themſelves all about to the inſide of the receiver, and there compoſed divers thin coats, or films, as it were, of ſulphureous matter ſticking to one another; which at their firſt taking off, and for ſome time after, might be bent or folded like leaves of paper, but afterwards harden in the air. Mineraliſts, and ſome other good authors, mention divers places, as abounding with marchaſitical foſſiles; but I am apt to think they are far more common, than is vulgarly taken notice of; for I have met with them, where one would little expect them. And though in *England* all our vitriol (which is now plentifully vended into foreign parts) be made of vitriolate ſtones, or bodies, that paſs for ſtones; yet that is not true, which our mineraliſts are wont thence to conclude, that there is no other vitriolate or marchaſitical matter in *England*: for a famous dealer in foſſiles having found a mine, which he knew not what to make of, and therefore carefully concealed, addreſſed himſelf to me, becauſe, he ſaid, he knew I would not betray or ſupplant him; and having at his deſire taken a private view of what he had diſcovered, I preſently found it to be a vein, that lay at ſome depth under ground, and ran along (how far I know not) like a vein of metalline ore, (and for ſuch, upon that account, he miſtook it) conſiſting of a black and heavy ſtuff, which, upon a few eaſy trials I quickly found to be of a vitriolate nature; inſomuch that, ſomewhat to my wonder, I was able to make it yield in few hours ſtore of pure vitriol, without any troubleſome or artificial preparation.

PROPOSITION II.

It is probable, that in divers places ſome endemical diſeaſes do mainly, or at leaſt in part, depend upon ſubterraneal ſteams.

UNDER the name of endemical diſeaſes, I do not compriſe thoſe only, that are very peculiar to this or that country; as the plica is ſaid to be to *Poland*, (whence it receives its name of *Polonica*;) or an odd kind of cholick in one part of *France*, (from which it is called *la Colique de Poictou*;) but alſo thoſe, that are more rife in ſome countries, than in moſt others; ſuch as agues in *Kent*, and in that part of *Eſſex* they call the *Hundreds*; the conſumption (though that be an ambiguous name) in *England*, whence foreign phyſicians call it the *Tabes Anglica*; and fluxes of the belly in *Ireland*, where they are ſo rife, as commonly to paſs under the name of the country diſeaſe.

THAT theſe endemical, or (if we may ſo call them) topical diſtempers, do in many places proceed from ſome exceſſive heat, moiſture, or other manifeſt quality of the air; from bad diet, vulgar intemperance, and other cauſes, that have little or no connexion with ſubterraneal reeks, I readily grant: but, that in ſome places the endemical diſeaſe may either be principally cauſed, or much fomented, by noxious effluvia, I am inclined to ſuſpect upon the following grounds.

1. THERE are ſome places, in which the endemical diſeaſe cannot be probably imputed to any manifeſt cauſe; as he may perceive, that ſhall conſider, how often it happens, that the cauſes, which are aſſigned of ſuch diſeaſes, if they were the true ones, muſt produce the like diſtempers in many other places, where yet it is notorious, that they are not endemical.

2. THAT ſubterraneal bodies may ſend up copious ſteams, of different kinds, into the air, has been already made out.

3. IT has been alſo ſhewn, that the matters, that ſend up theſe effluvia, may be of a large extent. And, I remember, on this occaſion, that I have ſometimes obſerved, and that in more countries than one, a whole tract of land, that abounded with minerals of one kind; and within no great diſtance, as perhaps a mile or a league, another large tract of land, whoſe ſubterraneal part abounded with minerals of a very differing ſort.

4. WE have alſo above declared, and it is highly probable from the nature of the thing itſelf, that thoſe copious ſteams (ſaline, ſulphureous, arſenical, antimonial, *&c.*) that impregnate the air, may very much conduce to make it hurtful to a human body, in the way requiſite to produce this or that determinate diſeaſe; as I not long ſince related from the chymiſt, that viſited the Hungarian mines, that in ſome places he found the reeks aſcending from them into the air (though in an elevated place, and expoſed to the winds) make him, as it were, aſthmatical, and give him a troubleſome difficulty of reſpiration. And here let me add an obſervation, which perhaps will not be thought fit to be ſlighted by phyſicians; namely, that ſome parts of the ſubſtance of the air (for I ſpeak not of its heat, coldneſs, or other ſuch qualities) do not only affect human bodies, or at leaſt many individuals among them, as they are taken in by reſpiration, but as they outwardly touch the ſkin; and the ſkin being (as I have elſewhere ſhewn) full of pores, and thoſe perhaps of different ſizes and figures, thoſe corpuſcles, that get in at them, may have their operation, even upon the moſt inward parts of the body. To make this more clear and probable, becauſe it is a thing of importance, I deſire theſe things may be obſerved.

1. THAT when I ſpeak of the air, I do not in this place underſtand that air, which I elſewhere teach to be more ſtrictly and properly ſo called, and to conſiſt of ſpringy particles; but the air in its more vulgar and laxe ſignification, as it ſignifies the atmoſphere, which abounds with vapours, and exhalations, and, in a word, with corpuſcles of all ſorts, except the larger ſort of ſpringy ones; and many of them may be ſo ſmall, and ſo ſolid, or ſo conveniently ſhaped, as to get entrance at ſome of the numerous orifices of the minute or military glandules of the ſkin, or at other pores of it. Thus, though paper be not pervious to the uncompreſſed elaſtical parts of the air, yet it may be eaſily penetrated by other corpuſcles of the atmoſphere; for I remember I have, for curioſity's ſake, prepared a dry body, out of a ſubſtance belonging to the animal kingdom, which, being lapt up in paper, would, without wetting or diſcolouring, or any way ſenſibly altering it, paſs in a trice through the pores of it in ſuch plenty, as to have not only a viſible, but a manifeſt operation on bodies placed at ſome diſtance from it. And though a bladder almoſt full of air, having its neck well tied, be held near the fire in various poſtures, the elaſtical air, though rarefied, or attenuated by the heat, will rather burſt the bladder, (as I have more than once found) than get out at the pores, yet we have often made a certain ſubſtance, belonging to the mineral kingdom, that, if a bladder were wet or moiſt, (as the ſkins of living men are wont to be) would readily pervade it, and have a ſenſible operation, even upon ſolid bodies placed within it. This experiment (that I can repeat when I will) is therefore the more conſiderable to our preſent purpoſe, becauſe in the bladder of a dead animal, the poroſity may be well ſuppoſed to be much leſs, than it was in the animal when alive; in which ſtate the parts of the human body are much more perſpirable, than one would eaſily believe; partly becauſe of the heat, that is continually diffuſed from the heart, and partly becauſe of the copious ſteams, that are in perpetual motion, and keep the parts warm, moiſt and ſupple: and it is not to be pretermitted in our preſent inſtance, that the bladder of urine conſiſts not of a ſingle membrane, and is probably of a ſtronger texture, by reaſon of the ſubtile ſalt liquor it is inſtituted to contain, than many other membranes of the body, or the epidermis. And this is the firſt thing I would have noted.

THE next is, that whereas in the inſtances newly recited, and ſome others, that are by and by to be mentioned, the effects were produced when the ambient air, impregnated with mineral corpuſcles, had but a very ſhort time (perhaps not many minutes) to work upon the body expoſed to it; in thoſe countries, that are very ſubject to endemical diſeaſes, the inhabitants are wont to live all the year long, and perhaps during their whole life, expoſed to the action of the vitiated air: and how much a far ſhorter time will ſerve, to make the corpuſcles, that rove in the air, penetrate into bodies of no very cloſe contexture, may be gueſſed by the breaking even of the bigger ſtrings of lutes and viols, by the numerous (though inviſible) vapours, that get into them in rainy weather; and much more by the effects of ſuch vapours, when inſinuating themſelves in ſwarms into the pores of a rope, they ſhorten it ſo forcibly, as to enable it, by ſhrinking itſelf, to lift up and keep ſuſpended conſiderable weights, as I have elſewhere ſhewn by trials purpoſely made. Theſe things may render it probable, that, though in a ſmall compaſs of time the noxious effluvia, that rove in the air, may be too thinly diſperſed in it, to inſinuate themſelves in any conſiderable number at the pores of the ſkin; yet, by reaſon of the continual contact of the air, (eſpecially as to the face, hands, and ſome other parts) which may laſt day and night for many months, or perhaps years, there may be opportunity for a conſiderable number of morbific particles to inſinuate themſelves into the cutaneous pores.

3. And thus having once got entrance, they may by the capillary veſſels, that reach to, or terminate at the ſkin, paſs on to ſomewhat larger veſſels; and ſo may get into the maſs of blood, and by its circulation be carried to all the parts of the body; and ſo be enabled both to deprave the blood, and other juices themſelves, and to gain acceſs to any determinate parts of the body, which their peculiar ſhapes, figures, *&c.* qualify them to produce ſome particular diſtemper in. This whole doctrine may be made more probable, by what experience ſhews of the virtues of certain plaiſters, eſpecially mercurial ones, in diſtempers, that are not at all, or at leaſt are not chiefly cutaneous; and (which comes more home to our argument) of the efficacy of periapta, and appenſa, ſuch as piony-root, blood-ſtone, lapis nephriticus, quick-ſilver in a quill, a dried toad in a ceſnet bag, *&c.* whereof though many anſwer not the characters, that are wont to be given of them, yet ſome of them experience has convinced me to be of greater efficacy, than I expected. And much more activity may be preſumed to be in divers noxious effluvia from ſubterraneal bodies; as may be gathered from the effects of the mercurial girdles, that ſome unwary perſons wear to cure the itch; and from what I elſewhere relate of the fits of the cholick, often produced in a friend of mine by the effluvia of maſſes of loadſtone. And this laſt example may ſerve for a proof of another part of our hypotheſis, by ſhewing, that mineral effluvia may not only be noxious in a general way, but may produce this or that determinate diſeaſe. That arſenical appenſa, though much extolled by divers phyſicians themſelves, and ſold dear by empiricks, as (if worn near the heart) wonderful amulets againſt the plague, have (eſpecially in ſome perſons and circumſtances) produced ſome of the noxious effects of arſenical poiſons, and particularly cauſed in ſome great faintneſs and diſpiritedneſs, I find by the teſtimony of divers eminent phyſicians. To which I ſhall add a remarkable one, which may probably be referred partly to this third obſervation, as well as to what I lately delivered about the bad effects of mineral exhalations breathed in with the air they vitiated: and I the rather mention this caſe, becauſe it is not only an odd one, but is a conſiderable argument to ſhew, that noxious mineral expirations may manifeſtly produce a determinate diſtemper in unlikely parts of the body. The obſervation is this; I knew, and on ſome occaſions employed, a chymical laborant, that fancied, that he could make a rare medicine out of red arſenick, (as ſome call what others ſtile ſandarach,) which is thought to differ little from common orpiment, ſaving its being much higher coloured: this laborant then working long and aſſiduouſly upon this mineral, and rubbing it frequently in a mortar, came divers times to me, and complained of a diſaffection he thence contracted in the organs of reſpiration; for which I gave him ſomething, that happened to relieve him; which encouraged him to complain to me of another diſtemper, that, though not ſo dangerous, did often very much moleſt him: which was, that when he was very aſſiduous in the preparation of his ſandarach, it would give him great pains, and (if I miſremember not) ſome tumours too, in his teſticles; and this, for aught I know, happened to him as long, as he was earneſt about that proceſs; for the medicines, that had relieved him in his other diſtemper, did not remove this; and I having occaſion to go for a while into the country, found him gone at my return. It may ſtrengthen the conjecture lately propoſed of the poſſible inſinuation of effluvia, that rove in the air, at the pores of the ſkin, if I add, that I have had the curioſity to enquire of more than one traveller, that had viſited the famous *Pico* of *Teneriff* (at whoſe upper part there are found ſcattered parcels of ſulphur, and divers manifeſt tokens of a vulcan) whether the ſulphureous ſteams (that I ſuppoſed to be copious near the top of the mountain) did not work upon the ſilver money they had in their pockets, and diſcolour it: to which he anſwered, that it was no uncommon obſervation to find, at men's return from viſiting the top of the hill, that the money they carried about them was blackened, and that he himſelf had particularly obſerved it to be ſo: which might eaſily gain credit with me, who have divers times made a preparation of ſulphur, which, even in the cold, ſends out exhalations ſo penetrant, that having, for trial's ſake, put ſome pieces of coin (which ought not to be golden) into a leather purſe, they were able, and that not in very many minutes, to diſcolour manifeſtly the money, in ſpite of the interpoſition of the purſe, that con-

tained it. But I had a more conſiderable inſtance of the efficacy of the ſulphureous expirations of the *Pico* of *Teneriff*, by a ſober perſon, that is one of the chief directors of the famous *Eaſt-India* Company of *London*; who being queſtioned by me about ſome circumſtances of his journey to viſit the top of that ſtupendous mountain, anſwered me, that among other effects the ſulphureous air had upon him, (who is of a very fine complexion) he found, at his return to the bottom, that his light-coloured hair had manifeſtly changed colour, and was in many places grown forked at the ends. Theſe obſervations may make it probable, that mineral exhalations may not only affect human bodies, as they are drawn into the lungs with the air they ſwim in, but as they inſinuate themſelves into the pores of the ſkin.

One conſiderable objection I foreſee may be made, againſt the propoſition I have been all this while endeavouring to render probable; namely, that it is ſcarce conceivable, that in ſo many ages, as endemical diſeaſes have afflicted ſome countries, the ſubterraneal matter, to which I do in great part impute ſome of them, ſhould not be waſted and ſpent. I might perhaps, on this occaſion, move a doubt, whether we have had ſuch continued accounts of the temperature of the air of all the countries, where diſeaſes are now endemical, as to know, that they have been always ſo; and that ſome of thoſe diſeaſes have not been worn out here or there, and ſome others have not of later ages begun to appear in this or that place: but contenting myſelf at preſent to have hinted this queſtion, I ſhall not ſtay to diſcuſs it, but proceed to offer three things, by way of direct anſwer to the objection.

1. And firſt, I think it very poſſible, that divers ſubterraneal bodies, that emit effluvia, may have in them a kind of propagative, or ſelf-multiplying power. I will not here examine, whether this proceed from ſome ſeminal principle, which many chymiſts and others aſcribe to metals, and even to ſtones, or (which is perhaps more likely) to ſomething analagous to a ferment, ſuch as in vegetables enables a little ſour dough to extend itſelf through the whole maſs; or ſuch as, when an apple or pear is bruiſed in one part, makes the putrified part, by degrees, to tranſmute the ſound into its own likeneſs; or elſe ſome maturative power, whereby an inanimate body may gradually admit of ſuch a change, or acquire ſuch qualities, as may be, in men's eſtimate, perfective of it, and perhaps give it a new denomination; as anana's in the Indies, and medlars, and ſome other fruits here in Europe, do, after they are gathered, acquire, (as it were, ſpontaneouſly) in proceſs of time, a conſiſtence and ſweetneſs, and ſometimes colour and odour, and in ſhort ſuch a ſtate, as by one word we call maturity or ripeneſs; and ſo ſome metalline ores, and ſome mineral earths themſelves, have been obſerved by mineralogiſts, to acquire, in tract of time, ſuch a change, as to afford ſome metal or other body, which either it did not afford before, or at leaſt did not afford ſo copiouſly, or ſo well qualified. This I have purpoſely made out in another paper; and the obſervation particularly holds as to nitre, which is thought to be the moſt catholick foſſile we have, and to be at leaſt one of thoſe foſſiles, that do the moſt plentifully emit effluvia into the air.

2. When I conſider, that even in thoſe mines, that are accounted deep ones, the ſpades of men are not wont to reach to the ten thouſandth part of the thickneſs of the earth between its ſurface and its centre, which yet is but its ſemi-diametre; I cannot but confeſs, that we know very little of the nature or conſtitution of the lower part of the terreſtrial globe; ſince we know little or nothing experimentally, of what lies beneath that, comparatively, very thin cruſt or ſcurf, (if I may ſo call it) that human induſtry has been hitherto confined to. And, upon this account, I do not think it abſurd to ſuſpect, that from the lower ſubterraneal regions there may be, either continually, or periodically, emitted into the regions of mines (if I may ſo call it) great ſtore and variety of mineral exhalations, which may continually repair the loſs of thoſe, that, from time to time, aſcend out of the foſſile region (as I may alſo call that of mines) into the atmoſphere. But the things I could alledge to countenance this conjecture, muſt not be inſiſted on in this place; therefore I proceed to conſider,

3. That bodies ſo heavy, and conſequently ſo abundant in parts of ſolid matter crouded together, as minerals and other foſſiles are wont to be, may well be ſuppoſed capable, without deſtructively waſting themſelves, to emit ſtore of ſuch minute particles, as effluvia, for an exceeding long time. This will be eaſily granted by him, that ſhall conſider the particulars laid together in a ſmall tract, that I purpoſely writ, about the admirable ſubtilty of effluvia; and it will be the more eaſily believed, if it be conſidered, how long ſome load-ſtones, ſevered from their mine, have been kept in the air, without any notable, or perhaps ſo much as ſenſible diminution of their virtue. And this brings into my mind what an eminent phyſician, who was ſkilled in perfumes, affirmed to me about the durableneſs of an effluviating power, that was not natural to a metal, but adventitious, and introduced by art; for he aſſured me, that he had a ſilver watch-caſe, that had been ſo well perfumed, that, though he uſually wore the watch in his pocket, it continued to be well ſcented ſixteen years. The ſame perſon had a way of perfuming factitious marble quite through, whoſe grateful ſcent he affirmed would laſt exceedingly; and of this perfumed marble he preſented me a ball, which having been ſome months after gotten from me by a great lady, I was diſabled from obſerving the durableneſs of the fragrancy.

I might perhaps be thought wanting to my cauſe, if, before I diſmiſs the propoſition I have been all this while diſcourſing of, I ſhould not obſerve, that ſubterraneal effluvia may contribute to endemical diſeaſes, not only as they vitiate the air, that men breathe in, or are immediately touched by; but as they may impregnate or deprave the aliments, that men feed upon. For firſt, they do mingle themſelves with the water, which either men drink itſelf alone, (as is the cuſtom with many nations, and of ſome men in moſt nations;) or make of it their beer, ale, or other factitious drinks, prepared of water and barley, oats, rice, *&c.* That divers ſprings and other waters are imbued with mineral corpuſcles, may be judged by ſome of the medicinal ſprings: for, though divers *acidulæ* and *thermæ* afford good ſtore of palpable ſulphur or ſalt, yet all do not; and having purpoſely examined a famous one, I could, with a pair of nice ſcales, ſcarce diſcover any ſenſible difference at all between the medicinal water, and the common water, that was to be met with thereabouts: and that, which impregnated this, and which I found by trial on myſelf, and ſome other bodies, enabled it to work very manifeſtly like a mineral water, was a ſort of corpuſcles ſo minute and ſubtile, that if the bottles were not kept well ſtopped, they would, in a ſhort time, vaniſh, and leave the liquor diſpirited. Experience has aſſured me, that there are ways of making common water violently and hurtfully operative upon human bodies, though its ſenſible qualities would not make one ſuſpect any change in it; but the ill uſe, that bad men may make of ſuch liquors, makes me forbear to expreſs myſelf more clearly; nor is it neceſſary, that I ſhould add any thing to confirm the propoſed conjecture, ſave what may be inferred from theſe two particulars: the firſt whereof is the ſcarce at all ſenſible change, that may be made in water, and ſome other liquors, that are made ſtrongly emetick by *crocus metallorum*, and by antimony vitrified without addition: and the ſecond may be taken from thoſe *Averni*, whence there continually aſcend ſuch pernicious exhalations, as in ſome places intoxicate or kill even the birds, that fly over thoſe poyſonous vents; for if ſuch exhalations, or even far leſs deadly ones, ſhould (as they may be reaſonably ſuppoſed, ſometimes to do) meet with either running or ſtagnant waters in their aſcent, there is little doubt to be made, but they will impregnate them, and make them noxious. And, on this occaſion, we may pertinently recall to mind, what I have formerly delivered about a place upon the borders of *Lancaſhire*, where the water and mud of a ditch is ſo copiouſly impregnated with ſubterraneal exhalations, (whether they be bituminous, ſulphureous, or of ſome unknown kind) that they may eaſily be fired at the ſurface of the water or earth, and made to burn like a candle, as an ingenious man did, at my requeſt, ſucceſsfully try.

BUT there is another account, upon which the effluvia of the lower parts of the earth may have a greater ſtroke in producing of endemical diſeaſes; namely, as they mingle with the water, and other liquors, that are neceſſary to the nutrition and growth of plants; and, by depraving thoſe juices, make the vegetables, that are nouriſhed by them, unhealthy for the men, that eat them, or make drinks of them. And theſe noxious exhalations may be ſuppoſed in many places to impregnate the juices of the earth much more copiouſly, than they do the running or ſtagnant waters lately ſpoken of; becauſe the difficulty of pervading the earth in their aſcent may ſo long check them, as to make them very numerous in a ſmall ſpace, and perhaps make them convene into bodies ſo far of a ſaline nature, as to be diſſoluble either in common water, or ſome other ſubterraneal liquor; by whoſe help, as by vehicles, they may inſinuate themſelves into the roots of plants, and be thence conveyed to other parts. Divers things might be alledged to keep this conjecture from being improbable, if I had leiſure to inſiſt on them; but I ſhall now only mention two things, that on this occaſion, come into my mind; the firſt whereof is, that inquiring of a famous chymiſt, who lived in a country abounding with mines of vitriol, whether he did not obſerve, that the oaks growing over them were more ſolid or heavy, than thoſe trees are elſewhere wont to be; he anſwered me, that he did, and that the difference was remarkable: the other is, that the parts of ſome minerals, (probably by reaſon of the ſmallneſs and ſolidity of the corpuſcles they conſiſt of) are capable of inſinuating themſelves very plentifully into the pores of growing vegetables, without being really ſubdued by what philoſophers are pleaſed to call the concocting faculty of the plant; and, inſtead of being aſſimilated by the vegetable, they retain their own mineral nature; and upon the receſs or evaporation of the juice, that ſerved them for a vehicle, may ſometimes diſcover their being mineral, even to an unaſſiſted eye; for I remember I have ſeen a piece of a vine, that grew not far from *Paris*, which being broken, I perceived a multitude of the internal pores of the root, and, if I miſtake not, part of the trunk alſo, to be ſtuffed with corpuſcles of a marchaſitical nature, as manifeſtly appeared by their colour, and their ſhining luſtre, and alſo by their weight.

THERE goes a tradition among learned men, that the leaves of vines, that grow in ſome places of *Hungary*, whoſe mines afford gold, are, as it were, gilt on the lower ſide, by aſcending exhalations of a golden nature. Whether this be true or no, I ſhall not take upon me to determine; but I remember, that having made inquiry about the truth of it, of a very ingenious traveller, whoſe curioſity led him to viſit heedfully thoſe famous mines; he told me, that he did not remember he had obſerved what is reported about the leaves of the vine; but he knew very well, that at *Tockay*, (a place, that affords the famouſeſt wine of *Hungary*, and indeed the beſt I have drunk) very many of the kernels of the grapes would appear gilt over, as it were, with leaf gold. To what has been already diſcourſed may be added, that ſince men are not wont to feed upon either beaſts, or birds of prey, as carnivorous animals uſually are, but upon ſuch as live upon graſs or ſeeds, or other vegetable ſubſtances, and drink nothing but fair water; the noxious exhalations, that make vegetables and water unwholſome, may, by their means, have a very bad influence upon ſheep, cows, deer, pigeons, and other animals, that feed upon ſuch depraved vegetables, and drink ſuch noxious waters; and conſequently may be very hurtful to thoſe men, that feed upon ſuch animals, and may, by the depraved aliment they afford, determine them to an endemical diſeaſe, ſuch as that vitiated nutriment is fitted to produce.

Perhaps it will not ſeem improper to add, on this occaſion, that it is poſſible, that in certain places the latent minerals may be of ſuch a nature, as that their effluvia may, inſtead of promoting, hinder the production of ſome particular diſeaſe, whether epidemical or endemical, in the bodies of them, that inhabit thoſe places. For, as phyſicians obſerve, that the more manifeſt morbifick cauſes of ſome ſickneſſes are quite contrary to thoſe of others; ſo I think it not improbable, that there may alſo be a mutual contrariety between thoſe latent morbifick cauſes, that are ſent up by ſubterraneal agents: and therefore it need to be no wonder, if ſome of theſe ſhould either diſable thoſe, to which they are hoſtile, or ſhould at leaſt work in human bodies a great indiſpoſition to admit their hurtful operations; which methinks thoſe phyſicians and chymiſts ſhould eaſily grant, who, with a boldneſs, that I do not applaud, preſcribe amulets, wherein arſenick, or ſome other poiſonous drug is employed, as preſervatives from the plague; againſt which I doubt the chief ſuccours they afford, proceed from the confidence or fearleſneſs they give thoſe, that wear them. But to return to our ſubterraneal effluvia; ſince there are divers whole countries, or leſſer places, that are either altogether, or in great part, free from this or that particular diſeaſe; as in ſeveral parts of *Scotland* agues, eſpecially, if I miſtake not, quartans, are very unfrequent; inſomuch that a learned phyſician anſwered me, that in divers years practice he met not with above three or four; and in ſeveral large regions of the *Eaſt Indies*, notwithſtanding the exceſſive heat of the climate, the plague is very rare: ſince (I ſay) theſe things are ſo, it ſeems not altogether improbable, that the ſubterraneal ſteams may contribute to this advantage, by impregnating both the air, the earth and the water, with corpuſcles endowed with qualities unfriendly to theſe diſeaſes; which ſeems to be ſomewhat the more credible, becauſe it has been obſerved, that ſome vaſt tracts of land will neither breed nor maintain venemous creatures, as is undoubtedly believed of the whole kingdom of *Ireland*, where I confeſs I neither did ſee any alive, nor met with any other that did; for as to ſpiders, though they breed in that country, where I have ſeen many of them, and ſometimes even upon Iriſh wood, yet they are unanimouſly believed not to be poiſonous there. And ſome writers tell us, how truly I know not, of ſome other countries, to which they affirm the like privilege to belong. But there is one inſtance afforded us by *Beguinus*, who travelled much to viſit mines, which, if it be ſtrictly true, is very notable for my preſent purpoſe. *Dignum admiratione eſt*, ſays he, *quod quamvis in vicinia Hydriæ comitatus Gloricienſis, ubi reperitur copioſè* ☿, *ſingulis ferè annis lues peſtifera graſſatur, illa tamen ſemper immunis ab hac manere ſoleat, idque viri provectæ ætatis ſe obſervaſſe, et à majoribus ſuis accepiſſe, mihi ſanctè confirmârunt.* “It is “worthy our admiration, (ſays *Beguinus*) “that though in the county of *Gloricia*, “where a great quantity of mercury is found, “the peſt almoſt every year raged, yet it is “always free from the plague. And this “was confirmed to me by perſons of a very “great age, who ſaid they had received it “from their anceſtors.” To which I ſhould add the teſtimony of the learned *Michael Mayerus*, who pronounces the mercury to be an *alexipharmacum* againſt divers diſeaſes, and particularly the plague, if I did not ſuſpect, by his way of mentioning this laſt diſeaſe, that he borrowed his encomium of mercury from *Beguinus*. But however, what has been related has invited me to conſider, whether there may not be ſome virtue, as well as ſome danger, in amulets of quickſilver, that are by many extolled againſt the plague: but this only upon the bye.

Proposition III.

It is likely, that divers epidemical diſeaſes are, in great part, produced by ſubterraneal effluvia.

I AM very well aware, that divers diſeaſes, that extraordinarily invade great numbers of people at the ſame time; (and were therefore by the Greeks called epidemical) may be rationally referred to manifeſt intemperateneſſes of the air, in point of heat, cold, moiſture, or ſome other obvious quality; and therefore the propoſition ſpeaks but of ſome epidemical diſeaſes, and imputes thoſe it ſpeaks of to ſubterraneal effluvia, not as total, but as partial, and ſometimes as principal agents in the production of them.

In favour of the propoſed conjecture thus explained, I ſhall offer two things to conſideration.

1. And firſt, it ſeems not very improbable, that divers of thoſe morbifick exceſſes (eſpecially if they be ſudden) that are obſerved in the air, may proceed from the unuſually copious aſcent of hurtful exhalations, that mingle with the air, and diffuſe themſelves through it. We are greater ſtrangers; than we commonly take notice of, to the ſubter-

raneal part of the globe we inhabit: and if I had leiſure, and thought it neceſſary, I could ſhew, that there are a great many odd and ſurpriſing things to be met with in the ſtructure and diſpoſition even of thoſe parts of the earth, that lye but a little way beneath the ſurface of it, and partly have been, and partly may eaſily enough be, actually penetrated by the induſtrious labours of men. And as for the deeper ſubterraneal regions, we are ſo much more unacquainted with them, that we are ſcarce fit ſo much as to conjecture, how far they extend, or what kind of materials they contain; and what is the groſs, and (if I may ſo ſpeak) the mechanical fabrick of the greater maſſes, whether ſolid or fluid, they conſiſt of: and leaſt of all can we determine, what motions, whether periodical, or others, theſe maſſes, or other portions of deeply lodged matter, may have.

On ſuch grounds as theſe I conceive it poſſible, that among the many and various effluviating bodies, that the terreſtrial globe may conceal in its bowels, there may be ſome, whoſe reeks aſcending plentifully into the air, may occaſion in it an exceſs of heat, cold, moiſture, thickneſs, or ſome other manifeſt quality. So that ſometimes (not to ſay many times) even thoſe manifeſt intemperateneſſes of the air, to which an epidemical diſeaſe is wont to be wholly imputed, (though perhaps not very juſtly) may in part proceed from ſubterraneal bodies; for I elſewhere ſhew, that theſe, by their conflicts, or mutual actions on one another, may excite great and ſudden heats, and on that account ſend up ſuch copious ſteams into the atmoſphere, as may produce there ſudden and exceſſive heats, lightnings, thunders, *&c.* And I ſhall now add (what perhaps will appear ſomewhat ſtrange) that I think ſudden and unſeaſonable refrigerations of the air may proceed from the action of ſubterraneal bodies upon one another: for trial purpoſely made has informed me, that there are certain minerals, whereof ſome may be employed in their crude ſimplicity, and the other requires but a ſlight preparation, ſuch as it may have in the bowels of the earth; which minerals being put together, will produce, by their re-action, an intenſe degree of cold, not only as to ſenſe, but when examined by a ſealed weather-glaſs.

The changes of the air, that produce epidemical diſeaſes, are ſometimes ſo great and ſudden, that they cannot, in my opinion, with probability be imputed to the action of the ſun or the moon, (which are cauſes that act in too general, and too uniform a way, to have thoſe particular and anomalous effects attributed to them) as probably as they may be to ſubterraneal bodies, that often act with more ſuddenneſs and impetuoſity, and without any regularity, at leaſt that is known to us. The difference we find in ſeaſons, that bear the ſame name, and ſhould be alike in temperature, is oftentimes very great, and ſometimes alſo very laſting. It is proverbially ſaid in *England*, that *a peck of March duſt is worth a king's ranſom*; ſo unfrequent is dry weather, during that month, in our climate. And yet in ſome years, and particularly the laſt, it was a rare thing to have a ſhower either in *March*, *April* or *May*. Sometimes in the month laſt named, there are heats greater, than in the dog-days of that ſame year; though uſually here in *England*, divers mornings of that month are cold, and ſome of them froſty: and now and then I have obſerved in the ſame months and days, at no great diſtance from one another, that the weather has been ſultry hot, and has alſo produced a great ſnow. We have ſeen ſummers like that, which is remembered for the ſiege of *Colcheſter*, that for almoſt the whole ſeaſon were more dark and rainy, than ſeveral winters have been obſerved to be. To which purpoſe I remember, that when I was about to write the hiſtory of cold, I was fain to watch a whole winter to find two or three froſty days, to make an experiment or two I had need of, that required not a cold, that was either laſting or very intenſe. But inſtances of this kind are ſo obvious to thoſe, that are at all heedful obſervers, that I may ſafely paſs them by, and inculcate, that the ſun, being in the ſame ſigns, at the ſame times of the year, it does not appear, how he ſhould produce ſo great a diſparity of the temperature of the air in ſeaſons of the ſame denomination; (as the winters or the ſummers of differing, and yet perhaps immediately conſecutive years.) And therefore I do not ſo much wonder, that many learned writers fly to aſtrology for an account of theſe irregular phænomena, and aſcribe them to the influences of certain ſtars; notwithſtanding what divers eminent philoſophers, and ſome great aſtronomers too, have ſaid to prove the vanity of judiciary aſtrology.

I shall not now ſtay to diſcuſs the queſtion, whether the ſtars have any influence diſtinct from their light and heat; becauſe, my opinion about it being ſomewhat peculiar, I have diſcourſed of it in a paper by itſelf. But this I ſhall now ſay, that the fixed ſtars being but general, and (if I may ſo ſpeak) indefinite agents, almoſt unimaginably remote from us, it is nothing near ſo likely, that ſuch effects, as (beſides that they happen very ſuddenly and irregularly) are oftentimes confined to a town, or ſome other narrow compaſs, ſhould be produced by certain ſtars; as that they ſhould be ſo by ſubterraneal bodies, which are near at hand, of very various natures, and ſubject to many irregular and differing motions, commixtures, re-actions, and other alterations. I have known a great cold in a day or two, invade multitudes in the ſame city with violent, and, as to many perſons, fatal ſymptoms; when I could not judge, (as others alſo did not) that the bare coldneſs of the air could ſo ſuddenly produce a diſeaſe ſo epidemical and hurtful: and it appeared the more probable, that the cauſe came from under ground, by reaſon that it began with a very troubleſome fog.

THAT there may be many ſubterraneal bodies, which by their commixtures may produce a ſudden heat, will be eaſily granted by thoſe, that know, (what I elſewhere purpoſely make out) that there are ſubterraneal menſtruums, and are acquainted with chymical operations, ſuch as the great efferveſcence made, when oil of vitriol is put upon filings of iron, or ſpirit of nitre upon butter of antimony: to which I might add many other of the like kind, that I have tried; as when ſpirit of nitre is put upon filings, either of iron, copper or tin, or upon crude quickſilver; which I ſhall content myſelf to have named, becauſe I have another inſtance, that comes cloſer to our preſent purpoſe. For whereas I have ſhewn above, that there is in many places great ſtore of marcaſital matter beneath the ſurface of the earth, and ſometimes very near it; I ſhall now add, that I have purpoſely tried, that putting a little ſpirit drawn from nitre, (with which ſalt the earth in many places abounds) or a little oil of vitriol, upon powdered marcaſites (which, being hard ſtones, are more difficultly wrought upon, than many other ſubterraneous marcaſitical bodies of a looſer texture) there preſently enſued a ſtrong re-action between the liquid and the ſolid bodies, whereby was produced much heat, not without viſible fumes, and ſtrongly ſcented, though not viſible, exhalations. And ſuch kind of odoriferous effluvia were emitted upon the putting a little ſpirit of ſalt upon our powdered marcaſites. And becauſe ſulphur is a mineral, that (either pure, or copiouſly mixed with others) is to be plentifully met with in the bowels of the earth, and in many places burns there; I ſhall add, that I have found acid ſpirit of ſulphur (made the common way) to work ſenſibly upon marcaſitical matter hard enough coagulated. An experienced German chymiſt relates, that in ſome parts of his country he met with vitriol ſtones, or marcaſites, that, by the action of mere common water reſting a competent time upon them, will grow ſo hot, as to enable the liquor to retain a ſenſible heat, when it had paſſed a pretty way from them. And, as I elſewhere ſhew, that many accidents may occaſion the breaking out of waters, or the change of their courſe in ſubterraneal places; ſo that common water may produce in a very ſhort time conſiderable degrees of heat in mineral bodies, may appear by mixing with two or three pounds of fine powder of common brimſtone a convenient quantity, (for now I remember not well how much I took) of filings of iron; for this mixture being thoroughly drenched with common water, did in a ſhort time grow intenſely hot, and ſend up ſuch a thick ſmoke, as good quicklime is wont to do, whilſt men ſlack it with water.

IT is obſervable to our preſent purpoſe, what account was given me by a domeſtic of mine, that lived in the north part of *England*, of a certain mineral groove, which he had often occaſion to reſort to: for when I aſked, whether the damp, that place was moleſted with, did frequently recur; he anſwered me, that at the time he was there, it would annoy the workmen, (if they did not take good care of themſelves) more than once in one day. And by inquiries, that I made of others, that were converſant in mines, I learned, that in divers places they were moleſted with damps, that came not at ſtated periods, but irregularly; ſometimes with much greater, and ſometimes with far leſſer intervals between them; the times of their duration being alſo not ſeldom unequal. So that, ſuppoſing ſuch noxious effluvia to be plentifully emitted from the lower parts of the ſoil, it need be no wonder, that an epidemical diſeaſe ſhould be rife in this or that parcular town or part of a country, without ſpreading much farther; and that it ſhould begin ſuddenly in places, where it was not expected: for beſides that theſe ſwarms of effluvia, being produced by caſual concourſes of circumſtances, may oftentimes be excited, and invade this or that place, without giving the inhabitants any warning; beſides this, I ſay, it is not always neceſſary, that theſe noxious effluvia ſhould be generated juſt under the places they moleſt, ſince the motion of the air, eſpecially when the wind ſits favourably, may ſuffice to carry them to the town or other place, that feels their ill effects: and yet they may ſeem to be almoſt confined to thoſe places; ſometimes becauſe the neighbouring places are not inhabited enough to make their ill qualities taken notice of; but more frequently, becauſe, by being diffuſed through a greater tract of air, they are more and more diſperſed in their paſſage, and thereby ſo diluted (if I may ſo ſpeak) and weakened, as not to be able to do any notorious miſchief.

AND here I conſider too, that it is not always neceſſary, that the harm, that is done by theſe morbid conſtitutions of the air, ſhould proceed only or preciſely from theſe ſubterraneal exhalations we are ſpeaking of, by virtue only of their own qualities, which they bring with them from under ground. For it is very poſſible, that theſe effluvia may be in their own nature either innocent enough, or at leaſt not conſiderably hurtful, and yet may become very noxious, if they chance to find the air already imbued with certain corpuſcles fit to aſſociate with them: for though theſe ſorts of particles were perhaps neither of them apart conſiderably hurtful, yet there may from their combinations reſult corpuſcles of a new and very morbifick nature.

THIS may be ſomewhat illuſtrated by conſidering, that the ſpirituous ſteams of ſaltpetre are not wont ſenſibly to work on gold, nor yet the ſpirituous parts, that the fire raiſes from ſal armoniac; and yet when theſe two ſorts of particles convene, there reſults from their coalitions certain corpuſcles of a new nature, that compoſe the liquor chymiſts call *aqua regis*, which by its fretting quality corrodes and diſſolves gold. By analogy to this we may conceive, that ſometimes the ſubterraneal effluvia may find the air already impregnated with ſuch corpuſcles, that, by aſſociating themſelves therewith, they may compoſe corpuſcles far more capable, than themſelves were whilſt apart, of having ill effects upon the maſs of blood, or ſome determinate parts of human bodies, and conſequently of producing diſeaſes there.

AND this inſtance may appear the more appoſite; becauſe it may be ſaid, that as though ſilver and gold, and diamonds and rubies, *&c.* be put together, and *aqua regis* be poured upon them, it will leave all the reſt uncorroded, and fall only upon the gold; ſo the newly produced corpuſcles, that I have been ſpeaking of, whether breathed in with the air in reſpiration, or carried up and down by the blood or other liquors of the body, may paſs by other parts of it without doing them any ſenſible harm, and attacking this or that determinate part, produce there ſome diſeaſe, ſuch as the fabrick and ſituation of that part peculiarly diſpoſe it to be affected with.

AND I ſhall add on this occaſion, that in our hypotheſis we may render a probable reaſon, why in ſome epidemical diſeaſes ſome perſons may eſcape much better than others, that ſeem likely to be, at beſt, as obnoxious to them, without a recourſe to the peculiar conſtitutions of the bodies of differing perſons; for it may be conjectured, that the noxious corpuſcles, that infeſt the air, may (eſpecially in windy weather) be very unequally diſperſed through the air, and many fly in far greater or leſſer numbers within equal ſpaces of air; and conſequently the perſons, that have the ill luck to be in the way of the more numerous ſwarms of morbifick corpuſcles, may be much more prejudiced by them, than others, though of weaker conſtitutions, who happen to be attacked but by few of them.

ON which occaſion I remember, that a great many trees in ſome land, that belongs to me, having been ſuddenly much endamaged by a wind, that was not able to do it by its bare ſtrength; I had the curioſity to view ſomewhat heedfully a tree, that ſtood in the garden, and perceived, that all the conſiderable miſchief was done to that ſide of the tree, which reſpected the corner whence the hurtful wind blew, the leaves of the other ſide continuing freſh and verdant, as being by the other part of the ſame tree fenced from the wind: and it was farther obſerved, that even the expoſed ſide of the tree was not every where endamaged; for there were divers parts, where the leaves continued ſound and green, though neighbouring leaves, were ſome more, ſome leſs (for all that were prejudiced were not totally) blaſted: the ſound leaves and the diſcoloured being ſo oddly mingled, that I conjectured the cauſe of the miſchief to have been this; that ſome arſenical or other corroſive or poiſonous exhalations, being ſuddenly emitted from the ſubterraneal parts into the air, were by the wind they chance to meet with there hurried along with it, and blown againſt the bodies, that ſtood in its way, moving in the air like hail-ſhot diſcharged out of a gun, here in a cloſer, and there in a more ſcattering order; ſo that as more or fewer of them happened to fall upon the ſame branch or leaf, they left more or leſs marks of their paſſage, by deſtroying the texture and colour in the leaves or parts of them they chanced to beat upon. And this may poſſibly be the cauſe of ſome of thoſe ſudden and ſometimes fatal effects, that I have known in ſome places the people talk much of, complaining, that ſuch a one had his eyes, or his face, or only one ſide of it, blaſted by a malignant wind; of which I thought I ſaw an example in a domeſtick of my own, whilſt in ſuch a wind he was riding after me, who (thanks be to God) had no ſuch miſchief done me.

BUT the vulgar have entertained ſuch ſtrange conceits and ſtories about theſe blaſtings, on which account ſome of them ſay, that men are planet-ſtruck, that the fabulous things mingled with thoſe, that are poſſible, have made intelligent perſons to reject them all.

ONE thing more I ſhall take notice of in favour of our hypotheſis; which is, that it well agrees with what has been obſerved, not without ſome wonder, of the very ſhort duration of ſome epidemical diſeaſes in certain times and places. For this may proceed from hence; either that all the morbific expirations aſcended into the air almoſt at once, or at leaſt within a ſhort time, and ſo were eaſily ſpent, that is, by diffuſion or diſperſion, ſo weakened, as to be diſabled from doing much miſchief; or elſe the ſubterraneal commotion, that produced them, may paſs on from one place to another, and ſo ceaſe to afford the air incumbent on the firſt place the ſupplies neceſſary to keep it impregnated with noxious exhalations: and it agrees well with this conjecture, that ſometimes we may obſerve certain epidemical diſeaſes to have, as it were, a progreſſive motion, and leaving one town free paſs on to another. Of which ſome obſervations, that I have made, incline me to think, that if phyſicians would heedfully mind it, they might take notice of ſeveral inſtances.

ONE thing more may be added, as conſonant to our hypotheſis; namely, that ſometimes an epidemical diſeaſe ceaſes in this or that place, almoſt as ſudden as it invaded, or at leaſt in a much ſhorter time, than phyſicians expected. For according to our hypotheſis it may well happen, that after ſome ſort of exhalations, whoſe peculiar qualities make them morbifick, have depraved the air incumbent on a particular place; there may, by a new or farther commotion of ſubterraneal bodies, be ſent up into the air ſtore of expirations of another kind, which meeting with thoſe, that formerly impregnated it, may either precipitate them, and ſo free the air from them; or by other operations on them, and ſometimes even by coalitions with them, ſo alter their nature as to diſable them from doing any farther miſchief.

THIS I ſhall illuſtrate, if not confirm, by that very remarkable phænomenon, that is yearly obſerved at *Grand Cairo* in *Ægypt*; for, (though I know not, whether or no the corpuſcles, that produce it, ariſe from under ground, the affirmative part of the queſtion being not improbable) it appears, that by the intermixture of adventitious corpuſcles with the formerly peſtilential air, it is ſo altered and corrected, that within one day or two, if not within a leſſer compaſs of time, there is a ſtop put to the progreſs of the plagues, that in the favourable time of year, namely, about the middle of ſummer, ſcarce ever miſſes of raging in that populous city: and, which is more admirable, theſe ſanative corpuſcles (if I may ſo call them) operate ſo powerfully, that of thoſe, that are already ſeized by that fataleſt of diſeaſes, the plague, few or none die of it, after once theſe antidotal particles have ſufficiently impregnated the air. I confeſs ſo great and ſudden a change is very wonderful, and I ſhould ſcarce think it credible, if I had not had the means and curioſity to inquire about it of divers perſons, ſome of them very intelligent, that either curiouſly viſited, or alſo made ſome conſiderable ſtay, in that great city, and found them agree in the main about the truth of the matter of fact: which is much confirmed to me by ſo eminent a teſtimony, as that of the learned *Proſper Alpinus*, who for ſeveral years practiſed phyſick in *Grand Cairo*, and as an eye-witneſs delivers what he relates more authentically, as well as more particularly, than any I have met with: and, though he endeavours to give ſeveral reaſons of this ſtrange and ſudden ceſſation of the malignity of the plague, yet I doubt they are not ſufficient for ſo wonderful an effect, unleſs we take in ſome new exhalations, that then impregnate and correct the air.

AND we ſhall ſcarce doubt of the great intereſt theſe have in the effect produced, if we give credit to what the recenteſt writer I have met with of voyages into *Ægypt*, has lately publiſhed about the annual peſtilence at *Grand Cairo*, a city he much frequented. This author, in the account he gives of the preſent ſtate of *Ægypt*, relates, that a little after the middle of our *June* (and uſually upon the very ſeventeenth day) there begin to fall towards the laſt quarter of the night, near the morning, certain drops of a kind of dew, which cauſes the river to be fruitful, and purifies the air from all the infection of camſims, by which I preſume he means the peſtilence: for, after ſome lines interpoſed, he ſubjoins, *The drops or dew purifies the air, for as ſoon as it falls, the plague ceaſes to be mortal, none dies of it; the air is wholeſome, all diſtempers ceaſe, and if any perſon grows ſick, he never dies.*

AND then, he adds, *This dew gives life to every thing; and when it falls upon the wheat, it cauſeth it to continue many years without corruption or worms, and is far more nouriſhing, than that corn, on which it never falls. For this cauſe they never houſe the corn of the Grand Seignior in the barns, till this dew is fallen upon it, that it might keep the longer without worms.*

AS well this conjecture, as ſome other things delivered here and there in this paper (about the ſalubrity of the air,) may probably gain the more credit, if I here ſubjoin, what I learned by inquiry from a very ingenious gentleman, who was owner of one or more of the mines, that afford the phænomenon I am to mention: which is this, that in the tin-mine countries in *Devonſhire* it ſometimes happens, (as perhaps I may have elſewhere noted to another purpoſe,) that upon a ſudden a ſpot of ground, and that not always narrow, will be, as it were, blaſted by the aſcending hurtful fumes; inſomuch that not only the graſs, fern, and other more tender vegetables, will be turned black, and, as it were, burnt or ſcorched up; but now and then trees alſo, without excepting oaks themſelves, will be blaſted and ſpoiled by the powerful operation of theſe ſubtile and poiſonous effluvia.

IT will probably be here expected, that among the epidemical diſeaſes, that our hypotheſis derives from ſubterraneal effluvia, I ſhould particularly treat of the cauſe of peſtilential fevers, and the plague itſelf. But, though ſome ſuch fevers may not improbably be in great part imputed to the noxious expirations of the globe we inhabit; yet as to the true plague itſelf, I freely confeſs I am at a loſs about its origin.

THE ſacred writings expreſly teach, that ſome plagues, and particularly that, which in *David*'s time ſwept away in three days 70000 perſons, have been in an extraordinary manner inflicted by God. And to me it appears either ſcarce poſſible, or far more difficult, than thoſe, that have not attentively enough conſidered the matter, are wont to think it, to deduce the abſtruſe origin, ſtrange ſymptoms, and other odd phænomena of ſome plagues, that are recorded in hiſtory, from merely corporeal cauſes.

ON the other ſide it ſeems unphiloſophical, and perhaps rather ſeems, than is very pious, to recur, without an abſolute neceſſity, to ſupernatural cauſes, for ſuch effects as do not manifeſtly exceed the power of natural ones; though the particular manner of their being produced is perchance more than we are yet able to explicate. And I think it the more queſtionable, whether all plagues are ſupernatural exertions of God's power and wrath againſt the wicked, becauſe I obſerve, that brutes (which are as well uncapable of moral vice, as moral virtue) are yet oftentimes ſubject to murrains, ſuch as may without incongruity be looked upon as the peſtilences of beaſts. And it is the leſs likely, that theſe ſweeping and contagious maladies ſhould be always ſent for the puniſhment of impious men, becauſe I remember to have read in good authors, that, as ſome plagues deſtroyed both men and beaſts, ſo ſome other did peculiarly deſtroy brute animals, of very little conſideration or uſe to men, as cats, *&c.*

UPON theſe and the like reaſons I have ſometimes ſuſpected, that in the controverſy about the origin of the plague; namely, whether it be natural or ſupernatural, neither of the contending parties is altogether in the right: ſince it is very poſſible, that ſome peſtilences may not break forth, without an extraordinary, though perhaps not immediate, interpoſition of almighty God, provoked by the ſins of men; and yet other plagues may be produced by a tragical concourſe of merely natural cauſes.

BUT though the difficulties, that incumber each of the oppoſite opinions, keep me both from dogmatically aſſerting, that all plagues have a ſupernatural origin, and from denying, that any have it; yet, to ſay ſomething on ſuch an occaſion, though I can ſpeak but very heſitantly, I ſhall venture to add, that, whether or no the true plague be ſaid to deſcend to the earth from a higher ſphere, than that of nature; yet its propagation and effects are (at leaſt for the moſt part) carried on mainly by a malignant diſpoſition in the air; without which ſome plagues could never have been ſo catching, as they were, nor ſo ſuddenly mortal; and that in divers peſtilences this malignant diſpoſition of the air may probably be in great part imputed to ſome kinds of ſubterraneal expirations, I am prone to think, and that chiefly upon two accounts.

THE firſt thing, that induces me to this conjecture, is, that not any of the ſeveral cauſes, to which the plague is wont to be imputed, ſeems to me to be ſufficient. Thoſe, that fetch it from the malevolent aſpects and influence of the celeſtial lights, beſides that they ſuppoſe ſome things, very difficult to be proved, have recourſe to agents too remote, too general, and too indeterminate, to be acquieſced in as the cauſes of ſuch particular ſymptoms and phænomena, as oftentimes accompany peſtilences. And as for thoſe other ſects of phyſicians, that confidently derive the plague, ſome from internal putrefaction, and others from exceſſive heats, noiſome ſtinks, corrupt aliments, and ſuch other celebrated cauſes; though each party alledges plauſible reaſons for its own opinion, yet their objections againſt their adverſaries are much ſtronger, than their arguments are for themſelves. And the learned *Diemerbroeck*, though his own hypotheſis ſeems to be more theological than philoſophical, has much enervated the arguments brought for the ſeveral opinions lately named, and by him diſſented from.

THE reaſons he employs to refute all the received opinions about the origin of the plague, except his own, are divers of them worthy of ſo learned a man, to whom, though I had leiſure to tranſcribe them, I ſhould refer the curious; my preſent deſign being only to deliver ſome few things, that ſeem more favourable to my conjectures, than to his opinion, and were ſuggeſted to me, partly by my own thoughts, and partly by the informations, that, to examine thoſe thoughts, I procured by conſulting ſome uncommon authors, and aſking queſtions of great travellers and navigators. By this means I came to learn, that divers great countries are uſually free from the plague, that, according to the vulgar hypotheſes, ought to be as much ſubject to it, if not more, than *England*, *France*, *Italy*, and thoſe other parts of *Europe* and *Aſia*, where that fatal diſeaſe rages from time to time in the parched regions of *Africk*, to which the exceſſive heats would make one expect, that the plagues ſhould make far more frequent viſits, than to our temperate European countries. *Leo Africanus* informs us, that ſome parts are ſo ſeldom afflicted with that dreadful diſeaſe, that it uſually ſpares the inhabitants 29 or 30 years together. And he expreſly records, that in *Numidia* itſelf, (if I much miſremember not the country's name,) notwithſtanding the raging heat of the climate, the plague is wont to be produced but once in a hundred years. Our * *Purchas* informs us, that in the land of the negroes it is not known at all. And to omit what ſome travellers and navigators relate of *Japan*, as if it were ſeldom or never invaded by the peſtilence; I do not remember, that in *New-England*, which contains a great extent of land, though I have had both curioſity and opportunity to inquire after the diſeaſes of that country, I ever heard the Engliſh take any notice of the plague, ſince their ſettling there above threeſcore and ten years ago. And as for the *Eaſt-Indies*, Sir *Philibert Vernatti*, a virtuoſo of great fame and authority at *Batavia*, where he reſides, in his ingenious returns to the queries ſent him by the Royal Society (of naturaliſts) anſwers thus] to the fifteenth: [*Peſtis morbus eſt Indiarum incolis incognitus*] "The plague is a diſeaſe unknown amongſt "the Indians." And of the countries, that lie yet more remote, as the great empire of *China*, and the kingdoms of *Tunquin*, and of *Cochinchina*, that great traveller *Alexander de Rhodes*, who ſpent 30 years in thoſe parts, affirms, that the plague is not ſo much as ſpoken of there: and yet the ſame Jeſuit does, upon grounds probable enough, eſtimate the number of the people of *China* alone to be two hundred and fifty millions; [a number I take to exceed by far that of all the nations of *Europe*.] Now when I conſider, how vaſt tracts of land are comprized in thoſe countries, ſome of which the plague does not at all, and others but exceeding unfrequently, invade; this immunity ſeems to me very unfavourable to moſt, if not all, the opinions received among phyſicians, as alſo that of *Diemerbroeck* himſelf, who derives the plague from a ſupernatural cauſe, the wrath of God againſt the ſins of men. For in regions of ſuch extent, and divers of them very populous, which are ſeated under very differing climates, and which are ſome of them inhabited by nations, that make war with numerous armies, fight bloody bat-

* *Purchas's Pilgrimage*, lib. 6. cap. 13.

tles, leave heaps of unburied bodies expoſed to the putrifying heat of the ſun; are ſometimes forced, as well as others, to live upon very unwonted and unwholſome foods; that worſhip ſtocks and ſtones, and beaſts, and ſome of them devils, whom they know to be ſuch; that are at leaſt as guilty as Europeans, of aſſaſſinates, poiſonings, rapes, oppreſſion, ſodomy, and other crying ſins: in theſe regions, I ſay, it is not imaginable, but that great intemperatures of the air, eſpecially in point of heat, ſtench of dead bodies killed in fights, unwholſomneſs of aliments, malevolent aſpects of celeſtial bodies, high provocations of the divine juſtice, and in ſhort, all the cauſes, to one or other of which the ſeveral parties of phyſicians are wont to refer the plague, ſhould be wanting any more than in our *Europe*; and yet the plague, which is preſumed to be the effect of one or other of theſe cauſes, is not here obſerved to be produced.

I KNOW, that it may be ſaid, that the hiſtorical things I have been reciting do not only oppugn the ſeveral received opinions of phyſicians about the cauſe of the plague, but diſfavour my conjectures too. But if this be ſaid, I deſire it may alſo be conſidered, that my judgment about the plague conſiſts of two parts: one, that it is exceeding difficult to aſſign the true and adequate cauſe of the origin of the peſtilence; and the other, that whatever be the cauſe of its firſt eruption, its propagation, and divers of its ſymptoms, may be probably enough referred to the depravation of the air by ſubterraneal ſteams, and their effects. If this be duly conſidered, the hiſtorical obſervations will appear not to overthrow the firſt member of our hypotheſis, but rather to confirm it; and it is upon this account, that I have mentioned them in this place: and as to the ſecond member, it may be ſaid, that ſince in the *Eaſt-Indies* and the other countries I have named, as privileged from this raging diſeaſe, it is not obſerved to break out; as it cannot be ſaid, that ſubterraneal effluvia do in thoſe countries promote the propagation of it; ſo it cannot be proved, that they could not do it, in caſe the plague were begun by other cauſes. But in regard I think it not improbable, that ſometimes the plague is not only fomented, but begun, by noxious expirations of the terreſtrial globe; I ſhall add, that this ſuppoſition, though I confeſs it be ſomewhat diſfavoured by ſome of the lately mentioned obſervations, yet is not abſolutely inconſiſtent with them. For firſt, it may be ſaid, that ſome of the countries I ſpeak of may be deſtitute of thoſe noxious minerals, to which we impute ſome plagues, it holding true in minerals as well as in plants, *Non omnis fert omnia tellus*. And to omit what I have not without ſome wonders obſerved, of the limits of differing ſorts of mines and mineral veins in very bordering parts of the ſame tract of land, I cannot but here take notice, that though ſulphur be in many countries uſually found, and that in plenty, where there are other metalline veins, inſomuch that chymiſts make it one of the three principles of all metals; yet in the mines of *England*, more ſtrictly ſo called, I do not remember I ever met with ſo much as an ounce of native ſulphur, and I could not find by divers mineraliſts, of whom I purpoſely aſked the queſtion, that they had met with any among the various mines they had frequented. It may alſo happen, that there may be hurtful minerals in a country, and yet not capable of often producing or promoting peſtilences there, even upon moderate earth-quakes. For it is poſſible, that theſe orpimental or other noxious minerals may have their beds or veins lying ſo deep in the earth, that they are not ordinarily able to ſend up effluvia ſtrong and copious enough to make a peſtilential depravation of the air; and even in leſſer earth-quakes the commotion or agitation of the ground, eſpecially if the earthquakes proceed (as one may ſuſpect, that divers of them do) from the ſudden fall of ponderous maſſes in the hollow parts of the earth, and the ſhakings of the ground thereby produced, and ſometimes ſpreading far, may not reach ſo far downwards, as much to affect theſe very deep mines, and yet ſome other more violent earthquakes may affect even theſe: upon which ground one may give ſome tolerable account, why the plague in ſome parts of *Africk* has been obſerved to rage but once in thirty or once in a hundred years; for there may be periodical paroxyſms, if I may ſo call them, or grand and vehement commotions in ſubterraneal parts, though men have not yet, for want of ſufficient longevity or curioſity, obſerved them. On which occaſion, I remember, that a late judicious French hiſtorian recounts, that in part of the laſt age, and part of this, a very pernicious diſeaſe of the nature of a cholick reigned in *France* every tenth year for a long tract of time. And the experienced * *Platerus* relates, that at *Baſil*, where with great ſucceſs he practiſed phyſick fifty ſix years, the city was afflicted with furious plagues once about every tenth year for ſeventy years together, of each of which peſtilences he gives a particular account in his uſeful obſervation. It may alſo farther be ſaid, that thoſe exhalations in the *Eaſt-Indies, &c.* that would otherwiſe be peſtiferous, may be corrected by other expirations, that may be either of benign nature, or of ſuch a nature, as, though noxious in themſelves, may fit them by combining with thoſe, that would be peſtiferous, to diſable them to be ſo; as I elſewhere obſerved out of *Beguinus*, that a country abounding in veins and maſſes of cinnabar, which is the ore of quick-ſilver, was preſerved from the plague, when the neighbouring regions were waſted by it. And I ſhall illuſtrate this matter ſomewhat farther, by taking notice, that though corroſive ſublimate be ſo miſchievous a mineral compoſition, that a few grains may kill a man, yet the fumes of this combined with thoſe of crude common quickſilver, which are them-

* Lib. 2. P. M. 323.

ſelves unwholſome enough, make *Mercurius dulcis*; which is a mixture ſo innocent, that being well prepared, and well adminiſtred, it is both ſafely and uſefully given even to children.

If what has been ſaid will not ſuffice, I ſhall propoſe another poſſible way of accounting for the immunity of ſome countries from the plague. For one may conceive, that in ſuch regions the ſoil, and other aſſiſting cauſes, may conſtantly produce in the air ſuch a conſtitution, as is found in the air of *Egypt*, during the time of the increaſe and overflowing of *Nile*, which uſually laſts every year for ſeveral weeks; for during this time the air is ſo antipeſtilential, that not only the plague does not make a new eruption, but is either wonderfully checked or quite ſuppreſſed in thoſe houſes, that it has already invaded; ſo that its mortal infection reaches no farther. And that it may not be thought incredible, that ſome countries may have, if I may ſo ſpeak, an antidotal nature, in reference to ſome pernicious evils, I ſhall repreſent, that there are ſome whole countries, which are privileged from producing vipers, toads, and other venomous creatures, as is vulgarly known concerning *Ireland*, where I could never ſee any ſuch, nor find by inquiry of either the natives, or Engliſh inhabitants, that they had met with any in that kingdom, where it is uncontrolled tradition, that if poiſonous creatures have been carefully brought there from other parts, they have died almoſt as ſoon as they came thither. There are ſome other iſlands, to which a like hoſtility to venomous animals is aſcribed: and as it ſeems not impoſſible, that ſome countries ſhould have a ſoil, that ſo impregnates the air, as to make it ſuppreſs or quite enervate many differing ſorts of poiſons; ſo others may, by their conſtitution, be qualified to maſter or reſiſt poiſonous expirations or wandering corpuſcles, that elſewhere are wont to produce the plague. And this may ſuffice for the firſt thing, whereon we ground our hypotheſis.

The ſecond thing, that invited me to the above propoſed ſuſpicion or conjecture, is, that it affords a not improbable account of ſome conſiderable things, relating to the production and phænomena of the plague.

(1.) As firſt, it is obſerved, that ſometimes the plague breaks out, when there has not preceded any ſuch immoderate diſtemper of the air, or any caſual enormity, capable of producing ſo great and anomalous an effect: nay, which is more, it has been obſerved, that very great and unuſual intemperateneſſes of the air have ſeveral times happened, and divers notable and threatning aſpects of the ſtars have been noted by good writers without being followed by the plague. The celebrated * *Fernelius* relates, that near the time he writ this obſervation, that year, which of all thoſe, that had paſſed in the memory of man, was all the world over the moſt immoderately hot, and was yet moſt heathful. And the ſame author reports the plague to have begun in the midſt of winter, and to have gone off in ſummer, and that ſeveral times ardent ſummers have been altogether free from the plague; which I alſo have noted to be true. *Johannes Morellus* obſerves, that in his country, after a dry winter, and wherein the north wind reigned, though it were ſucceeded by a moſt temperate and heathful ſpring, yet this brought in the plague, and that, when the north wind was predominant and the air pure and ſincere: which I the leſs ſcruple to believe, becauſe I obſerved ſomething very like it in the conſtitutions of the air, that preceded and accompanied the dreadful *London* plague, that broke out in the year 1665. Which phænomena much diſfavour their opinion, that impute the plague to the exceſſes of the manifeſt qualities of the air; but are agreeable to our hypotheſis, ſince by what has been formerly delivered, we may gather, that noxious ſubterraneal fumes may be ſuddenly, and without any warning, belched up into the air, and, by depraving it, produce fatal diſeaſes in many of thoſe, that are conſtantly ſurrounded by it, and draw it in, almoſt every moment, with their breath.

Of the deadly hurtfulneſs of divers ſubterraneal expirations, at their firſt eruption, there are many hiſtories extant in approved authors; and we have obſerved inſtances of that ſort in the times and countries we live in. But becauſe all poiſonous, and even mortal, exhalations are not therefore truly peſtiferous, but may, like many other poiſons, kill the perſons they immediately invade, without qualifying them to infect others; I ſhall add a paſſage out of that excellent hiſtorian, *Monſieur de Mezeray*, who relates in the life of *Philip de Valois*, "that "the plague, that happened in *France* in "the year 1346, was ſo contagious and de"ſtructive, that ſcarce a village, or even a "houſe, eſcaped uninfected by it. He adds, "that this peſtilence, than which none had "been obſerved more furious and ſpreading, "began two years before in the kingdom of "*Cathay*, by a vapour, that was moſt horri"bly ſtinking, which brake out of the "earth like a kind of ſubterraneal fire, con"ſumed and devoured above 200 leagues of "that country, even to the very trees and "ſtones, and infected the air in a wonderful "manner. From *Cathay*, ſays he, it paſſed "into *Aſia* and *Greece*, thence into *Africk*, "afterwards into *Europe*, which it ranſacked "throughout." Other inſtances of peſtilences begun by noxious ſubterraneal fumes I have met with in good authors; but cannot now recall the particulars to mind, and therefore ſhall paſs on to the ſecond obſervation.

See *Diemerbroeck de peſte*, lib. 1. c. 8.

(2.) In the next place then; whereas it is noted by diligent obſervers, that there is a wonderful diverſity in ſeveral countries, and even in the ſame country at ſeveral diſtant times, of thoſe raging diſeaſes, that phyſicians agree in calling the plague, (whence it happens, that ſuch medicines or methods of curing, as are in one plague ſucceſsful, as phlebotomy, purging, *&c.* do oftentimes in another prove dangerous, if not mortal;) whereas (I ſay) this great variety has been obſerved in plagues, it may be fairly accounted for, by the great number and diverſity, that has been actually found, or may be reaſonably ſuppoſed, in the numerous minerals, and other bodies, that nature has laid up in the ſubterraneal regions: eſpecially if we conſider, that the number of ſuch bodies may be much increaſed or diverſified, by the various combinations, which may be made of them, not only by caſualties, but by the action of ſubterraneal fires, and æſtuaries, and menſtruums, ſuch as I have elſewhere ſhewn to be lodged beneath the turf or ſuperficies of the earth. And the aſcending corpuſcles of thoſe mineral bodies, being moſt of them ſolid and ſubtile, may produce in the blood, and ſo in the body, far more odd and violent ſymptoms, than the peccant humours, that uſe to beget ordinary diſeaſes: which may be one reaſon, and perhaps the chief, why the ancient heathens, and *Hippocrates* himſelf, acknowledged in peſtilential diſeaſes θείον τί, ſomewhat of divine, ſurpaſſing ordinary nature.

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* *De abditis rerum cauſ.* lib. 2. c. 13.

WHAT theſe mineral ſubſtances are, whoſe ſteams produce ſuch odd and diſmal ſymptoms, I think exceeding hard to determine; yet, if I were to name one ſort, I ſhould perhaps think the leaſt unlikely to be orpiment. For, of the poiſonous minerals we are acquainted with, I know not any, of which there is greater quantity in the bowels of the earth; eſpecially taking that name in the latitude allowed it by thoſe ſkilful men, that make three ſorts of it, *viz.* yellow, red and white orpiment; divers of whoſe miſchievous effects ſeem to agree well enough with the ſymptoms of ſome plagues, and may be gueſſed to have at leaſt a conſiderable intereſt in the production of them. But yet, to ſpeak candidly, I do not think, that theſe minerals are the cauſes even of all thoſe peſtilences, whoſe efficients may come from under ground: for ſeveral reaſons, and ſome drawn from experience, make me think, that the ſubterraneal regions have many kinds of very miſchievous foſſiles, of which phyſicians, and even chymiſts, have no knowledge, and for which they have not any diſtinct names; and that the various aſſociations of theſe, which nature may by fire and menſtruums make under ground, and perhaps in the air itſelf, may very much increaſe the number and variety of hurtful matters, and alſo heighten their hoſtility to human bodies; as I think may be argued from the factitious white arſenick, that is commonly ſold in ſhops, which, though uſually made of orpiment, by the addition of ſo innocent a body as common ſalt, (which is found in great plenty under ground,) is obſerved to be far more poyſonous than orpiment itſelf. And I remember, that a ſkilful chymiſt having in my preſence taſted ſome prepared, and, as was thought, ſomewhat corrected arſenick, was quickly invaded by ſuch ſymptoms, as he thought would preſently kill him; but, through God's bleſſing, I quickly put him out of danger, though not out of pain, by early preſcribing him ſtore of oil of ſweet almonds, and ſomething made of lemons, that I chanced to have by me. But to return to what I was ſaying, ſandarach ſeems to be but orpiment, whoſe yellow colour is deepned to redneſs; and native arſenick, (for I have ſeen ſuch a thing, though it rarely comes into *England*,) ſeems to be little other, than pale or white orpiment. And indeed in *Hungary*, all three may be found not far from one another in the ſame mine, as I learned by inquiry from an obſerving eye-witneſs, by whoſe means, and of another chymiſt, divers native orpimental minerals (to ſay nothing of realgar, becauſe it is a factitious combination of orpiment and ſulphur) came to my hands. And as this ſort of foſſiles comprizes more numerous and various ones, than is noted, ſo the very noxious effects of the effluvia of orpiment are not unknown to divers phyſicians: and the learned *Sennertus* gives a particular inſtance of it in a painter, who upon opening a box, where orpiment, which men of his profeſſion uſe as a pigment, had been long kept, had his face all ſwelled, and was caſt into fainting fits. And as white arſenick is of a more piercing and corroſive nature, ſo it were not difficult to ſhew out of the writings of eminent phyſicians, that its effects have divers times proved very hurtful, and ſometimes mortal, when but externally worn in amulets, eſpecially if the pores of the ſkin were open by exerciſe and ſweat: and the nature of the ſymptoms produced ſeems to confirm our hypotheſis, ſince the perſons, that wore theſe arſenical amulets, were affected, ſome with great anxieties about the heart, ſome with inflammation, ſome with burning fevers, ſome with exulceration of the breaſts, ſome with puſtles like thoſe of the plague, and theſe were ſometimes black, as if made with a cauſtick: moſt patients were affected with great weakneſs and faintneſs, *&c.* as if they had ſwallowed poiſon; and of one young man it is recorded, that having heated himſelf in a tennis-court with an amulet upon his breaſt, the virulence of its corpuſcles made him fall down ſtark dead upon the ſpot. And it is a conſiderable circumſtance in theſe obſervations, that ſeveral patients were cured of the ſymptoms, that ſeemed to be peſtilential ones, by the ſame remedies, that are alexipharmacal againſt the plague: whence it may alſo be made probable, that the plague itſelf many times is a natural, though a dreadful and anomalous diſeaſe, since its effects and ſymptoms ſo much reſemble thoſe of acknowledged poiſons, and have been cured by antidotes effectual againſt other poiſons.

Senn. M. P. E. vi. p. 66.

I HAVE not time to mention, what I have myſelf tried and obſerved about the bad effects of orpiment, and its kinds. But I remember, that inquiring of an ingenious man, who ſometimes viſited a mine, which was known to abound with orpimental foſſils; he anſwered me, that when he walked over the neighbouring grounds, he found himſelf much diſordered, eſpecially in his thorax, by the effluvia; and that the mine-men and diggers were ſubject to a malignant anomalous and dangerous ſort of fevers, though he ſaid he was apt to impute, I know not how truly, ſome part of their obnoxiouſneſs to it to their drinking too much ſtrong wine. But though it is probable the effluvia of orpimental bodies may have a great intereſt in ſeveral plagues, yet I ſtrongly ſuſpect, that many others may proceed from the ſteams of ſuch ſubterraneal bodies, as are not yet diſtinctly known to us; and poſſibly have their effluvia variouſly combined, either beneath or above the ſurface of the earth: I ſay above; becauſe I have ſeveral times, and that without heat, combined ſeparately inviſible fumes of differing kinds into manifeſtly viſible ones in the free and open air.

And that the ſubterraneal effluvia may produce effects, and therefore probably be of natures, very uncommon, irregular, and, if I may ſo ſpeak, extravagant, may appear in thoſe prodigious croſſes, that were ſeen in our time, *viz.* in the year 1660 in the kingdom of *Naples*, after an eruption of the fiery mountain *Veſuvius*; of which prodigies the learned *Kircherus* has given an account in a particular diatribe: for theſe croſſes were ſeen on linen garments, as ſhirt-ſleeves, women's aprons, that had lain open to the air, and upon the expoſed parts of ſheets; which is the leſs to be admired, becauſe, as *Kircher* fairly gueſſes, the mineral vapours were by the texture, that belongs to linen (which conſiſts of threads croſſing one another for the moſt part at or near right angles) eaſily determined to run along in almoſt ſtraight lines croſſing each other, and conſequently to frame ſpots reſembling ſome one, and ſome another kind of croſſes. Theſe were extremely numerous in ſeveral parts of the kingdom of *Naples*; inſomuch that the Jeſuit, that ſent the relation to *Kircher*, ſays, that he himſelf found thirty in one altar-cloth, that fifteen were found upon the ſmock-ſleeve of a woman, and that he reckoned eight in a boy's band: alſo their colour and magnitude were very unequal, and their figures diſcrepant, as may appear in many pictures of them drawn by the relator; they would not waſh out with ſimple water, but required ſoap; their duration was alſo unequal, ſome laſting ten or fifteen days, and others longer, before they diſappeared. And theſe croſſes were found not only upon linen garments expoſed to the air, but upon ſome of thoſe (belonging to altars) that were kept locked up in cheſts (to which poſſibly they might have acceſs by the key-holes, or ſome unheeded chink.) To which ſtrange phænomena if I had the leiſure to add ſome others, that I have met with in *Agricola*, and other approved authors, whoſe relations my memory doth not now ſerve me particularly to cite; I preſume it would appear yet more probable, that ſubterraneal effluvia may now and then be of a very anomalous nature, and produce ſtrange effects, and among them variety of peſtiferous ones in the air.

But, to add this upon the bye, though I fear phyſicians will not be able to diſcover all the ſubterraneal bodies, whoſe effluvia produce or contribute to the plague; yet I do not think it impoſſible, that, by diligent obſervations and trials, ſagacious men may diſcover divers of them, and perhaps antidotes againſt them.

And though the buſineſs of this paper be to treat of the cauſes, not the remedies of the plague; yet I love mankind too well, to ſuppreſs on this occaſion an obſervation, that, by God's bleſſing, may in ſome caſes ſave the lives of many. In the late great plague, that ſwept away ſo many thouſands at *London*, there ſtaid in the city an ingenious phyſician, that was bred by the learned *Diemerbroeck*, (whoſe book *de Peſte* I prefer to any I have yet read of that diſeaſe.) This doctor (whoſe name I am ſorry I have forgotten) hearing, that I was deſirous to receive an account of the plague from ſome intelligent eye-witneſs, and having ſoon after ſome occaſion to paſs near the place in the country, where I then reſided, was pleaſed to give me a viſit, and a rational account of the main things I deſired to know; and when I inquired about his method of cure, after he had told me, that he had twice had the plague himſelf, whereof he ſhewed me ſome effects, he added, that after many and various trials he perceived, that abundance of his patients died, after the buboes, (carbuncles) or peſtilential tumours appeared; becauſe upon a little refrigeration of the body by the air, and oftentimes by the very fear, that diſheartned the patient, the tumors would ſuddenly ſubſide, and the peſtilential matter recoiling upon the vital parts, would quickly diſpatch the fatal work. Wherefore he bethought himſelf of a method, by means of which, he aſſured me, he had not loſt one patient of very many he treated, if he could but, as he uſually did, by good alexipharmical, and cordial remedies, enable and excite nature to expel the peccant matter into a tumour; for then he preſently clapped on an appropriated drawing plaiſter, which would never ſuffer the tumor to ſubſide, but break it, or make it fit for an opening; and thereby give nature a convenient vent, at which to diſcharge the matter, that oppreſſed her. This plaiſter, it will eaſily be thought, I was deſirous to know; and he told me it was a chymical one, and that it was no other than the *magnes arſenicalis* of *Angelus Sala*, whoſe deſcription, becauſe the book, wherein it is found, is in few hands, I have here annexed. If this prove as ſucceſsful in other plagues, as it did to thoſe, that uſed it in that of *London*, there will be juſt cauſe to admire and praiſe the benignity of divine providence, which in a poia poiſonous mineral, that probably does oftentimes concur to produce the plague, has laid up a remedy for it.

Emplaſtrum attractivum peſtilentiale noſtrum.

℞ *Gummi ſagapeni, ammoniaci, galbani an.* ℥iij. *Terebinthinæ coctæ, ceræ virginis ana* ℥ivſs. *Magnetis arſenicalis ſubtiliter pulveriſati* ℥ij. *radic' Aronis pulveriſat'* ℥i. *Gummi depurentur cum aceto ſcyllitico, & ad conſiſtentiam emplaſtri coquantur, & poſtea ponderentur, deinde cum rebus aliis fiat emplaſtrum lege artis: hoc emplaſtro carbunculus obducatur, quod paucis horis venenum extrahit.*

An attractive Peſtilential Plaiſter.

“ Take, of the gums ſagapen, ammoniac, galbanum three ounces, of boiled turpentine and virgin-wax four ounces and a half, of the arſenical loadſtone well pulveriſed two ounces, of *Aron*'s root pulveriſed an ounce; let the gums be depurated with the vinegar of ſquills, and boiled to the conſiſtency of a plaiſter, and laſtly weighed: then according to the uſual method with other things make up a plaiſter; cover the carbuncle with this plaiſter, and in a few hours it will draw out all the venom.”

Præparatio Magnetis Arſenicalis antea dicti.

℞ *Arſenici Chryſtallini, ſulphuris vitri, antimonii crudi ana: hæc tria in mortario ferreo pulveriſentur in vaſe fortiſſimo vitreo; ponantur ad ignem arenæ, donec vitrum optimè incaleſcat, & prædicta ſolvantur & liquentur inſtar picis, quod obſervabitur, quando filum quoddam immittitur in fundum, quod extractum poſtea inſtar Terebinthinæ trahetur ubi ſatis coctum erit: poſtea remove vitrum ab igne, &, ubi refrigeratum eſt, rumpe, & ſubtiliter pulveriſa, & ad uſum ſerva.*

The true preparation of the fore-mentioned arſenical loadſtone.

“ Take equal parts of cryſtal-arſenick, of ſulphur of glaſs, of crude antimony; bray them to powder in an iron mortar, ſet them in a ſtrong glaſs on a fire of ſand, till the glaſs be very hot, and the fore-mentioned drugs melted like pitch; which you ſhall know, when having thruſt a thread into the bottom, the matter ſticking to it does rope like turpentine; which is a ſign of its being well enough boiled: remove then the glaſs from the fire, and when it is cold break it; reduce the matter into ſmall powder, and keep it for your uſe.”

By the ſame motive, *Philanthropy*, I am induced to add on this occaſion, that having had ſome opportunity to oblige an antient and very experienced phyſician, to whoſe care was committed a great peſthouſe, where the contagion was ſo ſtrong, that he loſt three phyſicians, that were to be aſſiſtants to him, and three chirurgeons of four, that were to be ſubſervient to him; I deſired to learn of him, if he counted it not too great a ſecret, what antidote he uſed to preſerve himſelf from ſo violent and fatal an infection. This requeſt he readily granted, but withal told me, that his method would not ſeem to me worth mentioning, if I were one, that valued medicines by their pompouſneſs, not their utility. For, beſides ardent prayers to God, and a very regular diet, his conſtant antidote was only to take every morning faſting a little ſea-ſalt in a few ſpoonfuls of fair water; which he made choice of, both becauſe it kept his body ſoluble without purging or weakning it, and for other reaſons, which I muſt not now ſtay to ſet down. I know this medicine may appear a deſpicable one; but yet, in my opinion, it ought not to be deſpiſed, after ſuch experience, as I have related, has recommended it. For I think it deſirable, that notice be taken of all remedies, that have been found by good trials, not bare conjectures or uncertain reports, available againſt the plague: for, ſince peſtilencies, as we have lately noted, are exceeding various in their kinds, it is very poſſible, and not unlikely, that their appropriated remedies may be ſo too; and therefore I would not eaſily lay aſide every medicine, that this or that learned phyſician may ſpeak ſlightly of, or even may declare, that he has found it unſucceſsful againſt the plague; ſince the ſame medicine may be available in a peſtilence of another kind, in which perhaps the remedies commended by the phyſician we ſpeak of will be found inefficacious.

This conſideration forbids me to paſs by, what happened to me in the great *London* plague above-mentioned; namely, that a very learned phyſician having once recommended to me an herb little noted in *England*, as a moſt effectual and experienced antidote againſt the plague, I cauſed it to be cultivated in a garden (as I ſtill do every year;) and when the peſtilence raged moſt, having ſome of it by me made up with a little ſugar in the form of a fine green conſerve, I ſent it to two infected perſons, who, by the divine benediction on it, both of them recovered. But having made but thoſe two trials, I dare not ground much upon them only; though I uſually keep the plant growing in a garden, partly becauſe both the taſte and colour, one or other of which in moſt antidotes is offenſive, are in this pleaſant; and partly becauſe ſome little experience has invited me to believe the commendations, that I have found given of it againſt the bitings of venomous creatures: whereof I remember a notable inſtance is recorded by *Petrus Spebrerius* of a Roman, who having with his ſtaff pierced or cruſhed a viper, that he took to be dead, had ſo ſtrong a venom tranſmitted along the ſtaff, that the enſuing night he had a very great inflammation in both his lips, to which ſupervened an exceeding ardent fever and ſtrange tortures; from all which *Serianus Pacyonius*,

In obſervat. nobil. apud Schenkium, *l.* 7. *Obſerv. Med. Tit. de venenis ex animalibus.*

a noted phyſician, that was called to him, freed him, as it were, by miracle, by the juice of goat's-rue, or, as others call it, galega, that grew copiouſly in that place. It may without diſguſt be taken ſomewhat plentifully, (and ſo it ought to be) in its entire ſubſtance as a ſalad; or elſe one may give its conſerve, its ſyrup, or, which is better, its juice newly expreſſed.

(3.) It likewiſe agrees with our hypotheſis, that ſometimes the plague ceaſes, or at leaſt very notably abates of its infectiouſneſs and malignity, in far leſs time, than, according to the wonted courſe of that ravenous diſeaſe, phyſicians did, or rationally could expect. For ſometimes it may happen, that, though the temperature or intemperateneſs of the air continues the ſame, the matter, that afforded the peſtiferous exhalations, may be either ſpent under ground, or ſo altered by combination with other ſubterraneal bodies, or by ſome of thoſe many accidents, that may happen, altogether unknown to us, in thoſe deep and dark receſſes. And if once the fountain of theſe noxious effluvia be ſtopt, ſo that thoſe, that are in the air, ceaſe to be recruited, the wind and other cauſes may in a ſhort time diſſipate them, or at leaſt dilute them with innocent air, ſo far, as to keep the diſeaſe they produced from being any thing near ſo miſchievous as before. And here I conſider, that it may ſeveral times happen, that though the minerals, that emit the hurtful expirations, remain where they were under ground, and be not conſiderably waſted; yet their fatal effects may not be laſting, becauſe the effluvia were generated by the conflict of two or more of them, which vehemently agitated one another, and ſent up fumes, which ceaſed to aſcend, at leaſt in great plenty, when the conflict and agitation ceaſed: as I have tried, that by putting good ſpirit of ſalt upon filings of ſteel or iron in a conveniently ſhaped glaſs, there will be made a great conflict between them; and without the help of external heat, there will be ſent up into the air ſtore of viſible fumes of a very ſulphureous odour, and eaſily inflammable; which copious elevation of fumes will leſſen or ceaſe, as does the tumultuous agitation, that produced them. And ſo likewiſe, if you pour *aqua fortis* upon a convenient proportion of ſalt of tartar, there will be at firſt a great ebullition produced, and, whilſt that continues, ſtore of red and noiſome fumes will be elevated, but will not outlaſt the commotion of the mixture, whoſe active parts will in no long time combine into a kind of nitrous ſalt, wherein the noxious parts of the menſtruum are as it were pinioned, and hindered from evaporating or aſcending, though really they retain much of their priſtine nature, as I elſewhere ſhew.

It may alſo happen, that ſoon after that commotion of ſubterraneal matter, which ſent forth peſtiferous exhalations, a more intenſe degree of ſubterraneal heat, or perhaps the ſame latent fire, extending itſelf farther and farther, may force up fumes of another ſort, that being of a contrary nature, may be, if I may ſo ſpeak, antidotal againſt the former; and by precipitating them, or combining with them, may diſable them from acting ſo miſchievouſly, as otherwiſe they would. To countenance which I ſhall tell you, that I have ſometimes purpoſely made diſtillations, in which one part of the matter being, after the operation ended, put to the other, there will enſue a ſudden and manifeſt conflict between them, and ſometimes an intenſe degree of heat. And that mineral exhalations, though otherwiſe not wholeſome, may diſable peſtiferous effluvia, may be gathered from what I lately noted about a country, which abounding with veins of cinnabar, was, probably by their expirations, preſerved from the peſtilence. And our hypotheſis will perhaps appear ſomewhat the more probable, if we reflect on what I lately mentioned of the ſudden check, that is almoſt every ſummer given to the plague, which at that time is wont to reign at *Grand Cairo*. For ſince it is generally obſerved and complained of, that morbific cauſes do their work much more effectually, than ſanative ones; it ſeems very probable, that exhalations aſcending from under-ground into the atmoſphere may be capable of producing peſtilential fevers, and the plague itſelf, ſince thoſe corpuſcles, that impregnate the Ægyptian air upon the ſwelling of the nile, are able to put a ſpeedy ſtop, not only to the contagiouſneſs but to the malignity of the plague, even when it is aſſiſted by the ſummer heat, which at *Grand Cairo* is wont to be exceſſive.

But having inſiſted perhaps too long on this Egyptian peſtilence, I ſhall only add, by way of illuſtration of the conjecture, that invited me to mention it, that the acceſſion even of expirations, that are not themſelves wholeſome, may ſometimes ſerve to correct the air, and put a ſudden check to an epidemical diſeaſe; for corpuſcles of differing kinds may by their coalitions acquire new qualities, and each ſort of them loſe ſome of thoſe they had before: as, ſuppoſe there wandered in the air a great many effluvia, which by their determinate ſhape and bulk were apt to corrode or irritate the lungs, or the membranes of the brain, *&c.* as thoſe of nitre are to corrode ſilver; it may happen, that another ſort of reeks, though in their own nature unwholeſome, may, by aſſociating themſelves with the firſt ſort, and compoſing with them corpuſcles of new qualities, aboliſh or much weaken the noxious ones they had before, in reference to this or that part of the human body. Though the ſpirits of ſaltpetre will readily corrode ſilver; yet if you add to them (as for ſome purpoſes I am wont to do) about half as much, or leſs, of the ſpirituous particles of common ſalt, (which yet are corroſive enough, and will fret aſunder the parts of iron, copper, antimony, *&c.*) there will emerge a body, that will not at all corrode pure ſilver.

PROPOSITION IV.

It is very probable, that moſt of the diſeaſes, that even phyſicians call new ones, are cauſed either chiefly or concurrently by ſubterraneal ſteams.

THE product of my firſt endeavours to bring credit to the foregoing propoſition appearing to have miſcarried, when I came to ſend to the preſs the things I had written about it; that at leaſt what can be preſerved of it may not be loſt, I ſhall ſubſtitute inſtead of it the following account.

AT the entrance of my diſcourſe I obſerved, that the term *new diſeaſe* was much abuſed by the vulgar, who are wont to give that title to almoſt every fever, that, in autumn eſpecially, varies a little in its ſymptoms, or other circumſtances, from the fevers of the foregoing year or ſeaſon. And therefore I declared, that by new diſeaſes I meant only ſuch, whoſe ſymptoms were ſo uncommon, that phyſicians themſelves judged them to deſerve that appellation; ſuch, for inſtance, as the ſudor Anglicus or ſweating ſickneſs; that diſeaſe, which the learned *Wierus* and others call in Dutch *Die Varen*; an unheard of diſeaſe deſcribed by *Ronſeius*, that in the year 1581 invaded and deſtroyed many in the dukedom of *Lunenburg*; to which many phyſicians add the rickets, and others generally the *lues Venerea*. Having cleared the terms, I next conſidered, whether there were really any new diſeaſes properly ſo called, and gave ſome reaſons to ſuſpect, that ſome diſeaſes, which among phyſicians themſelves have paſſed for new, were extant before *in rerum natura*, though not in the country, wherein even the learned judged them to be new. And I intimated, that to examine this ſuſpicion throughly, it is not ſafe to acquieſce in the books of phyſicians only; but it is fit to conſult the writings of geographers, whether antient (among whom I particularly recommended *Strabo*) or modern, together with the relations of hiſtorians, navigators, and other travellers. And here I inquired, without determining any thing, whether the *lues Venerea* be, as moſt phyſicians are wont to ſuppoſe, a diſeaſe wholly new, or only new to our European world, and brought hither from ſome African or other remote region, where it may be probably ſuſpected to have long been endemical.

BUT taking it for granted, with the generality of phyſicians, that ſome new diſeaſes are to be admitted; I advanced to conſider ſome of the cauſes, to which they may be imputed, and to give ſome reaſons, why I do not acquieſce in their opinion, though very general, that derive them only or chiefly from the varying influences of the heavenly bodies: for the moſt powerful of thoſe, namely the ſun and moon, act in too general and indeterminate a way, to afford a ſufficient account of this affair; and as for the other lights, the fixt ſtars, beſides their being univerſal and indefinite agents, their ſcarce meaſurable remoteneſs makes it juſtly queſtionable, whether they have any ſenſible operation upon any part of our bodies, ſave our eyes. And, though I deny not, that great intemperateneſs of the air, as to the four firſt qualities, as heat, cold, drineſs, and moiſture, are wont (not over juſtly) to be called, may diſpoſe men's bodies to ſeveral great diſtempers, and may alſo be concurrent cauſes of thoſe we are ſpeaking of; yet neither can I acquieſce in theſe, when I conſider, how much more frequently they happen, than new diſeaſes do; and that their action, though various, is too general and indeterminate to perſwade me, that they can be the adequate cauſes of effects ſo rare and anomalous, as diſeaſes odd enough to deſerve the title of new.

BUT now, the ſubterranean region of our globe, beſides that it is always near us, abounds with variety of noxious minerals, and probably conceals great quantities of differing ſorts of them, that are yet unknown to us; and ſince we have elſewhere proved, that there want not cauſes in the bowels of the earth to make great and irregular, and ſometimes ſudden confluxes, conflicts, diſſipations, and other conſiderable changes, amongſt the materials, that nature has plentifully treaſured up in thoſe her ſecret magazines; and ſince, in making out the three former propoſitions, we have manifeſted, that the ſubterraneal parts of the globe we inhabit, may plentifully ſend up noxious effluvia of ſeveral kinds into the air: it ought not to ſeem improbable, that among this emergent variety of exotick and hurtful ſteams, ſome may be found capable to diſaffect human bodies, after a very uncommon way, and thereby to produce new diſeaſes, whoſe duration may be greater or ſmaller, according to the laſtingneſs of thoſe ſubterraneal cauſes, that produce them. On which account it need be no wonder, that ſome new diſeaſes have but a ſhort duration, and vaniſh not long after their appearing, the ſource or fomes of the morbific effluvia being ſoon deſtroyed or ſpent; whereas ſome others may continue longer upon the ſtage, as having under ground more ſettled and durable cauſes to maintain them: which laſt part of the obſervation may be illuſtrated by what happened in *Calabria*; which province, though it have been obſerved to have acquired, within theſe two or three ages, the faculty of producing manna upon certain trees*; yet this great change, though ſudden enough, had it ſeems ſuch ſtable cauſes, as well as of great extent, that it hath laſted ſeveral ſcores of years, and continues in that country to this day.

A diſcourſe of ſubterraneal ſteams as they affect the air.

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* C. Magnenus *de manna, cap.* 9. *Dic amabo,* Altomari, *cur ante trecentos annos nullum manna fuit in Oenotria; jam certe aderant pagi ibidem urbeſque vicinæ neque, fefelliſſet curioſam incolarum ſolertiam, &* c. 15. *ante* 240. *annos nullum Mannæ Calabrenſis in autoribus veſtigium eſt.*

I AM not ignorant, that the whole doctrine propounded in the four propoſitions about the inſalubrity of the air is not at all comfortable either to patients or phyſicians: but important theories deſerve to be inquired into, and, if true, to be delivered, though we could wiſh they were untrue. And judicious men rather thank than blame thoſe, that have given us accounts of latent or unſuſpected, though perhaps irremediable cauſes of diſeaſes and of deaths; or have recorded the hiſtories of ſome poiſons, whereof the true antidotes are yet unknown. Uncommon notions about diſeaſes may ſerve to enlarge the phyſicians mind and excite his attention and curioſity: and, beſides that they may keep him from too obſtinately perſiſting in the uſe of received medicines, though unſucceſsful, upon a ſuppoſition, that the diſeaſe can have no other cauſes, than thoſe wont to be aſſigned it by Claſſic authors; beſides this, I ſay, I do not deſpair, but that either the ſagacity or fortune of this inquiſitive age, or at leaſt of poſterity, may by the bleſſing of God be happy enough to find proper remedies, even for thoſe diſeaſes, that proceed from ſubterranean effluvia, when once by proper ſigns they ſhall be diſtinctly obſerved; of which power of appropriated remedies I have known ſome inſtances, as to the very bad ſymptoms produced by antimonial and ſome other mineral fumes.

SOME of the points diſcourſed of, under the fourth propoſition, were of affinity enough to paradoxes, to have need of being illuſtrated or confirmed by obſervations and experiments. And therefore having accidentally retrieved ſome of this laſt named ſort, I ſhall venture to ſubjoin them as a ſpecimen, though without tranſitions or applications, but juſt as I found them thrown together, in one looſe ſheet, wherein I lighted on them. But it is time to conclude with the recital of the promiſed experiments; which I would immediately do, but that I hold it fit to premiſe, by way of introduction to them, that I hope the things hitherto diſcourſed will appear much the more probable, if we ſhall prove, by experiments, that, which ſeems much leſs likely, than any thing we have above delivered; namely, that metals completely formed and malleable may be elevated into the air, and that perhaps without any great violence of fire, in the form of exhalations and vapours; the ſingly inviſible corpuſcles ſtill retaining their metalline nature. This, at leaſt, as to ſome metals, I have endeavoured to prove in another tract, intitled, *A Paradox about the Fuel of Flames.* But becauſe that diſcourſe was never publiſhed, I will here ſet down two or three experiments, (not mentioned, that I remember in it;) which I do the more willingly, becauſe it may be a thing of no ſmall moment in phyſick, if it be ſhewn, that fixed and ſolid bodies, ſuch as metals are, may by art be reduced into ſuch minute corpuſcles, that, without loſing their nature and all their properties, they may become parts of fumes, or perhaps of inviſible vapours, or even of flame itſelf.

Particulars belonging to the fourth Propoſition.

EXPERIMENT I.

WE took three parts or pounds of Dantzic vitriol (which is blue, and ſomewhat partakes of copper) and two parts or pounds of good ſea-ſalt; theſe being very well powdered and mixed, were diſtilled with a ſtrong naked fire, to force out all, that could be driven over; and by this means we not only obtained a ſpirit of ſalt of a manifeſtly blueiſh colour, but there aſcended alſo a conſiderable quantity of powder, which, being ſhaken with the liquor, ſettled at the bottom of it in the form of a powder, which was judged to conſiſt of corpuſcles of a cupreous nature, and perhaps alſo of ſome of a martial nature. But I unhappily neglected the opportunity of examining this powder, which came up in quantity enough to have ſerved for various trials.

EXPERIMENT II.

BY ſubſtituting Engliſh vitriol (which is green, and is much more abundant in iron than that of Dantzic) and proceeding in other reſpects as in the former proceſs, we obtained a very yellow ſpirit, with a conſiderable quantity of a yellowiſh powder, that was gueſſed to be a kind of *crocus martis*.

EXPERIMENT III.

WE took very thin plates of copper, and caſt them into a retort, upon an equal or a double weight (for we did not always uſe the ſame) of good mercury ſublimate; and luting on the receiver, gave a fire by degrees for ſeveral hours; by which means we uſually obtained ſome running mercury, (which ſeemed to be very well putrified, and was perhaps alſo impregnated) together with ſome ſublimate, that had not faſtened upon the copper. And at the bottom of the retort we had good ſtore of a ponderous and brittle ſubſtance, that did not look at all like a metal, but rather like ſomething of a gummous or reſinous nature, being alſo fuſible and inflammable almoſt like ſealing-wax. This, having not opportunity to proſecute the experiment at home, I put into the hands of an induſtrious phyſician, that was earneſt with me to impart to him the proceſs, and let him purſue it for me. He, according to my directions, expoſed this metalline roſin, (if I may ſo call it) groſly beaten to the free air, where it did, according to expectation, in a ſhort time, change colour, and turn to a kind of verdegreaſe; which being diſſolved in good ſpirit of ſalt, gave a ſolution

tion of a very lovely green colour. This being ſlowly diſtilled *ad ſiccitatem*, yielded but a very weak and phlegmatick liquor; and the *caput mortuum* was again diſſolved in freſh ſpirit, and the menſtruum abſtracted as before. This was done ſeveral times, till the matter was ſo impregnated, that the menſtruum, being drawn off from it, came over as ſtrong almoſt as when it was put on. This done, the thus impregnated verdegreaſe was diligently mingled with Tripoly, or ſome ſuch inſipid and fixed additament, and diſtilled with a ſtrong fire; by which means it afforded good ſtore of a liquor colourleſs, like common water; which made the phyſician ſuppoſe the experiment had miſcarried, till I having dropped into it a colourleſs liquor, namely ſpirit of hartſhorn or of ſal-armoniac, he was much and delightfully ſurpriſed to find it preſently diſcloſe a deep and lovely blue colour. What afterwards became of this odd ſpirit, I need not here declare; what has been ſaid being ſufficient to ſhew, that corpuſcles of copper may be elevated in the form of exhalations, both tranſparent and colourleſs. The next following experiment, though in part mentioned by ſome chymiſt, is here ſubjoined, becauſe it is neceſſary, and applied to a particular purpoſe.

EXPERIMENT IV.

IF from good Corniſh tin, you warily diſtill an equal or double weight of Venetian ſublimate, into a very large receiver, very well luted on to the retort, you will obtain a ſpirituous liquor, which, as ſoon as the free air comes to touch it, will ſend up abundance of white exhalations, in the form of a thick ſmoke, which will continue to be emitted much longer, than one would imagine. But that, which I deſire to have particularly obſerved in this experiment, is, that though this liquor be thus apt to emit ſmoke, not only plentifully, but, as one would think, with violence, yet I found by trial, that even when I put it into a veſſel, not ſtreight mouthed, if I did but lay a piece of a ſingle leaf of paper flatwiſe upon the orifice of the glaſs, ſo as cover it all, the viſible production of the fumes would preſently ceaſe; and the liquor would lie like common water, as long as the paper lay, though but lightly, upon the glaſs; though upon the removal of that, the liquor would ſend up plentiful fumes as before: which ſeems to argue, that ſome metalline ſubſtances may, by the contact of the air, have their copious aſcenſion into the atmoſphere very much helped and promoted, as if the air had ſaline or other ſort of particles in it, that are, in reference to ſome mineral bodies, of a very volatizing nature. The way, by which I have divers times elevated the fixedeſt of metals, gold itſelf, I have delivered in another paper, and ſhall not here repeat it. But I ſhall now ſet down an experiment, that, when it is carefully made, is eaſy to be performed, and yet affords a notable and ſenſible proof, that the corpuſcles of a metal may be made to aſcend, and that plentifully, even with a very moderate heat, under the form of ordinary fumes or ſmoke. To effect this I deviſed the following experiment.

WE took copper, and diſſolved it in good aqua fortis, till the menſtruum was ſatiated with it; in the ſtrong ſolution we ſteeped a while ſome brown, or other porous paper, that being fitter than the finer to ſoak up the menſtruum; then ſlowly evaporating the ſuperfluous moiſture, we put a quantity of this imperfectly dried paper upon the hearth, at ſuch a diſtance from a fire of actually flaming wood, that the paper was not kindled, but yet was ſo ſcorched, as to afford very plentiful fumes: theſe looked like ordinary ſmoke, whilſt they moved through the air, and would queſtionleſs have mingled with it, and been diſperſed through it, if the body, that emitted them, had not been purpoſely placed for a future deſign. But when the motion of the air towards the flame had carried theſe fumes to it, the metalline ſmoke did, as I expected, diſcloſe its nature; for being actually kindled, it tinged the flame of a lovely colour, for the moſt part blue, and ſometimes green, as it happened to be variouſly mixed with the flame aud ſmoke of the wood.

AN

AN HISTORICAL ACCOUNT OF A Strangely ſelf-moving LIQUOR.

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AN ingenious teacher of mathematicks, having occaſion to make a compoſition for a new fire-engine, whereof he was to ſhew his majeſty a trial, mingled divers ingredients in an earthen-pot over kindled coals; but could not, or did not, do it ſo warily, but that the matter took fire, and began to blaze furiouſly, which obliged him to ſtifle the flame as haſtily as he could; and having removed the veſſel from the fire, and ſuffered it to grow cold, when afterwards he came to look upon it, to ſee if what remained might be of any uſe to him, he was ſurprized to find it variouſly and briſkly moved. Wherefore having ſet it aſide, to be ſure, that it might be thoroughly cold, he, after ſome hours, viſited it again, and found it move as before: and having caſt ſtore of ſeeds upon it, to ſee if the liquor would move them alſo, the bituminous part of it connected them into a kind of thick ſcum, that covered moſt of the ſuperficies; but yet left ſome intervals, in which the liquor appeared, and diſcovered, that it continued its motions. Two days after, the engineer diſcourſing with me of his fire-work, about which he had adviſed with me before, told me, among other things, of this odd accident. And when I had aſked him, if the motion continued ſtill, and had been anſwered affirmatively, though it was then a dark night and ill weather, my diffidence, or my curioſity, made me engage him to ſend for the pot as it was; partly to be ſure of the matter of fact, and partly to try, if the knowledge I had of the ingredients, which he had before told me, would afford any hint of the cauſe of ſo odd an effect; a like to which in kind, though not in degree, I had many years before deviſed, and ſucceſsfully practiſed, the way of producing.

THE veſſel being come, though the haſty tranſportation of it ſeemed to have ſufficiently diſturbed it, there did appear manifeſt ſigns of ſuch a motion, as the engineer had aſcribed to it; and therefore he being willing to leave it with me, I cauſed it to be ſet aſide in a laboratory, where ſome furnaces kept the air conſtantly warm, and did there and elſewhere, at diſtant times, look heedfully upon it, now and then diſplacing, or quite taking off, ſome of the thick ſcum, that too much covered the ſurface of it; and by this means I had the opportunity to take notice of ſeveral phænomena, whereof theſe are the chief.

FIRST I obſerved, that the motion of this liquor was not only briſk, but very various; ſo that having looſened ſome ſmall portions of the ſcum from the reſt, one of them would be carried towards the right hand for inſtance, and another towards the left, at the ſame time. — 2. Where the liquor firſt came out from under the ſcum, it ſeemed to move the moſt briſkly, flowing almoſt like a ſtream, whoſe motion upwards had been checked, and, as it were, reverberated, by that incumbent obſtacle. — 3. Several motions in this liquor were the more eaſy to be obſerved; becauſe, though it were dark, yet it was not uniform; conſiſting in part of oily and bituminous ingredients, which, though they ſeemed to have but one common ſuperficies with the reſt of the liquor, yet, by their colours and power of vigorouſly reflecting the light, they were eaſily enough diſtinguiſhable from the reſt. And I often obſerved, that ſome of theſe unctious portions of the matter, emerging to the ſurface of the liquor, though perhaps at firſt one of them would not appear bigger than a pin's head, yet, in moving forwards, it would, at the ſame time, diffuſe itſelf circularly, and make, as it were, a great halo, adorned with the colours of the rain-bow and ſo very vivid, as afforded a very pleaſant, and at firſt ſurprizing ſpectacle; theſe phantaſms often nimbly ſucceeding one another, and laſting, till they loſt themſelves againſt or under the thick ſcum. — 4. The motions of this odd liquor were not only various, but frequently vortical; to be ſatisfied of which I ſometimes put ſhort bits of ſtraw, or fragments of ſome ſuch like ſtuff, upon the diſcovered part of the ſurface of the liquor, by which they were carried towards very diſtant, if not oppoſite, parts of the veſſel at the ſame time. But to make the vortical motion more evident, I ſeveral times detached conſiderably large pieces of the thick ſcum from the reſt of the body; and had the pleaſure to ſee them move both with a progreſſive motion in crooked lines, and with a motion about their own middlemoſt parts. All this while the liquor, whoſe parts were thus briſkly moved, was actually cold, as to ſenſe. — 5. To obſerve what the preſence, or abſence, of the free air would do to this liquor, I cauſed many ſpoonfulls of it, with ſome of the ſcum, to be put into a cylindrical glaſs, which, though large itſelf, had a neck belonging to it, that was but about the bigneſs of one's thumb, that it might be well ſtopped with a cork. But having, by this means, kept the free air from having a full and immediate contact with the whole ſurface of the mixture, as it had, when that mixture lay in the wide-mouthed veſſel, I could not perceive the liquor to move to and fro, no not though the orifice of the neck were left open; whereas having, at the ſame time, poured ſome of the liquor into a very ſhallow and wide mouthed veſſel, called in the ſhops a clear caked glaſs, it moved rather more than leſs nimbly and variouſly than in the great earthen-pot, (which yet was of the ſame ſhape) and ſhewed us many of thoſe vivid and ſelf-dilating circles, that have been mentioned in the third number. And theſe, by the fineneſs of their colours, and the quickneſs, wherewith they ſucceeded one another, afforded a delightful ſpectacle, as long as I ſtayed to obſerved the liquor.— 6. Though the motions of the hitherto mentioned liquor did not ſeem to be always equally briſk, yet they appeared to continue manifeſt and various in ſome diverſities of weather, as to cold and heat; and when I looked on it by candle-light, as well as by day-light. And, when being not well enough to viſit it myſelf, I ſent one purpoſely to look upon it, about ten a clock at night, he brought me word, that it continued to move as formerly, and ſo it has done for ten days. And how much longer it will continue to do ſo, time muſt determine.

POSTSCRIPT.

Some time after the foregoing account had been written, when I came to look upon the liquor (which in the mean time had been ſeveral times viewed, and appeared to retain its motions) I found, to my trouble, that ſome body's impertinent curioſity and heedleſſneſs had cracked the lower part of the earthen-pot; at which overture the liquor, though not the ſcum, was run out: which had put a period to our obſervations, but that foreſeeing, that ſuch an accident might happen, I had long before taken out ſome ſpoonfulls of the liquor, and kept it cloſe ſtopped in a vial. By this means I had the opportunity to obſerve, that when I poured out the liquor into a wide mouthed veſſel, it would move as before, though this were done ſome weeks after it had been put up. And I remember, that long after having one day received the honour of a viſit from a foreign miniſter, who was an inquiſitive perſon and a man of letters, we chanced, among other things, to talk of this liquor: and though it were ſcarce to be hoped, that it could ſtill retain any of its motive virtue, yet, to gratify his curioſity, and that of ſome ingenious men there preſent, I cauſed the vial to be brought, and having unſtopped it, I poured out the liquor into a convenient ſhaped veſſel; in which, after we had ſuffered it to reſt a while, they were delightfully ſurprized to ſee it move, (though not, in my opinion, quite ſo briſkly as before, yet) very manifeſtly and variouſly. This encouraged me to think it poſſible, that it might retain ſome motion, though but languid, ſeven or eight weeks after; and therefore on the 25th of *July* I looked upon it again, and having cauſed it to be poured into a China cup, it manifeſted, at firſt, a briſk and various motion: but this, after a while, did ſo ſlacken, that I began to have ſome ſuſpicion, that the motion it was put into by effuſion, and the firſt contact of the air, might have given it the greateſt part of its agitation. But this being but ſuſpicion, I put the veſſel into divers poſtures in a widow, the better to diſcover the true cauſe of this phænomenon; but whilſt I was buſy about this, which ingroſſed my intention, a miſchance overturned the cup, and, by throwing down the liquor, put an end to my ſpeculation: yet this miſchance hindered me but from obſerving, how long the odd agitation of our liquor would have continued, but not from finding, that it laſted a great while; for I ſhewed it the foreign miniſter about, or after, the beginning of *June*, that is, about five months, or more, after the liquor was firſt obſerved to move.

OF THE

Reconcileableneſs of SPECIFIC MEDICINES

TO THE

Corpuſcular PHILOSOPHY.

To which is annexed

A Diſcouſe about the Advantages of the Uſe of SIMPLE MEDICINES.

The PREFACE.

THE riſe of the following tract, intimated near the beginning of it, was not ſuch a fictitious thing as the reader may imagine: but though I really received a viſit from a phyſician, known to me but by his reputation, purpoſely to propoſe to me his objections againſt the corpuſcular philoſophy, and he had a long conference with me about them; yet, becauſe the hiſtorical paſſages of that interview cannot be circumſtantially related in few words, I ſuppoſe the reader will willingly allow me to employ this preface, in giving him advertiſements about the ſcope and deſign of the treatiſe it uſhers in.

I SHALL therefore advertiſe him, that he will be much miſtaken, if he ſhall expect, as I perceive ſeveral have done already, to find in this book a collection of receipts, of ſpecific remedies: for a moderate attention to the title page will enable him manifeſtly to diſcern, that the following paper, in its own nature, and in the direct and immediate deſign of it, is a ſpeculative diſcourſe; ſince it tends but to ſhew, that, in caſe there be ſpecific medicines (as it is probable there are ſome) their experienced virtues are reconcileable to the principles of the corpuſcular, or (as many call it) the new philoſophy; and, at leaſt, do not ſubvert them, if theſe effects and operations be not clearly explicable by them. And as this is the avowed ſcope of the following eſſay, ſo I choſe to treat of it leſs like a phyſician than a naturaliſt; for phyſicks being a ſcience, whoſe large extent invites and warrants its cultivators to ſearch into the nature and phænomena of things corporeal indefinitely, it muſt often happen, that the medicinal art, and this ſcience, will be converſant about the ſame ſubject, though in differing ways, and with differing ſcopes; for there are divers hurtful or advantageous accidents and changes of the human body, whereof the naturaliſt takes notice, but as they are phænomena, or changes produced by natural cauſes in the body of an animal, whilſt the phyſician conſiders them as ſymptoms of diſeaſes, or effects of medicines; the former directing his ſpeculations to the diſcovery of truth, and the other his theory to the recovery of health. But becauſe I elſewhere particularly conſider the cognation and diſtinction between the diſcipline, that the naturaliſt, and that, which the phyſician cultivates, I ſhall forbear to mention them in this place; but rather acknowledge, that I ſcarce doubt, but that I might have inriched the following diſcourſe with ſome choice particulars, if I would have peruſed and borrowed from the learned writings of the famous Dr. *Willis:* but beſides that I had not his books at hand, I was unwilling to be prepoſſeſſed or byaſſed by his notions; and I preſumed the perſon I wrote to would not be unwilling to ſee, what, without their help, the conſideration of the thing I treated of ſuggeſted to me. About this I ſhall now proceed to obſerve, that though the direct ſcope of the following diſcourſe being to explicate the phænomena of ſome bodies, which, from their uſe, are called medicinal, and declare how poſſibly they may produce the effects aſcribed to them, the enſuing diſcourſe is for the main of a ſpeculative nature; yet the conſequences, that may be drawn from it, and the applications, that in this induſtrious age, are like to be made of ſome things, that it contains, may probably render it practical. For I have more than once obſerved, that divers conſiderable remedies, and ſome not unpromiſing methods too, have either remained unthought of, both by many Galenical phyſicians, and divers of their modern antagoniſts too; or, if propoſed by others, have been rejected or ſlighted, barely upon this ſuppoſition, that no rational account can be given of their way of working, or how they ſhould do good; and it is ſaid to be unworthy of a rational phyſician to make uſe of a remedy, of whoſe manner of operating he cannot give a reaſon. How prejudicial it may be to many patients, that phyſicians be prepoſſeſſed with a bad opinion of an uſeful remedy, may be gueſſed by him, that ſhall conſider, what multitudes of teeming women, that probably might have been ſaved by the ſkilful uſe of phlebotomy, have been ſuffered to die for want of it, upon a diſlike of that remedy, that phyſicians for many ages thought to be grounded upon no leſs authority than a poſitive aphoriſm of *Hippocrates*. And therefore, if, to remove the ſpecious objection newly mentioned againſt that whole kind of remedies called ſpecifics, the following tract has been ſo happy as to ſhew, that it is at leaſt poſſible, that medicines, ſaid to be ſpecific, may perform their operations by ways, which, though not explicable by the vulgar doctrine of the ſchools, are intelligible, and reconcileable to the clear principles of the mechanical philoſophy: if, I ſay, this have been done by the theory propoſed in this treatiſe, it may conduce ſomewhat to inlarge the minds of many phyſicians, and invite them to make uſe of ſeveral remedies, of which they did not think, or againſt which they were prejudiced. And ſince ſpecifics, where they can be had, are wont to be free from any immoderate manifeſt quality, and for the moſt part to work more benignly, as well as more effectually, *cæteris paribus*, than other medicines; I think that to bring them into due requeſt, and invite phyſicians to ſearch for new ones, as well as employ thoſe already known, may tend much to ſhorten many cures, and make them more eaſy and more ſafe.

Eſt aliquid prodire tenus, ſi non datur ultra.

The Advertisement of the Publisher.

THE author had occaſion to touch upon ſome of the ſame ſubjects, that he here treats of, in a book, *The Uſefulneſs of Experimental Philoſophy*, long ſince publiſhed; but he had the miſfortune to be reduced to write the following diſcourſe about the ſpecific medicines, and the utility of ſimple remedies, in a village, where he had not that book at hand, and could not call to mind all, that he had therein publiſhed ſeventeen or eighteen years before: on which account, though he ſtudiouſly forbore to repeat the particulars, that he remembered to have ſet down in that treatiſe, how appoſite ſoever they would have been to his preſent purpoſe, yet having, ſince the following diſcourſe was ſent to the preſs, got a ſight of that other (which he had not read in many years) he finds, upon a tranſient view, that ſome of the ſame things are mentioned in both books: at which diſcovery, though he be ſomewhat troubled, yet he is the leſs ſo, becauſe they are but few, in compariſon of the new ones, and ſet down on ſuch occaſions, or with ſuch other circumſtances, that may make a favourable reader look on them, as not bare repetitions. And though in the forecited treatiſe, ſome of the motives to make uſe of ſimple medicines, be lightly touched; yet beſides that they are not all, that are mentioned in the following invitation, thoſe arguments, that are there but pointed at, are here treated of, and both confirmed, and explained by other obſervations and receipts. And ſince the printed book abovementioned has been for divers years very ſcarce, it is preſumed, that thoſe many readers, that have it not, will not be diſpleaſed to find here ſome few things, for which they cannot reſort thither: and as the author foreſaw he might be obliged to conſent to the tranſlation of the following papers into the Roman tongue; ſo he thought his Latin readers would not repine, though a great number of particulars had been borrowed of a book, that is not yet extant in their language.

I shall give you no farther account of the particulars contained in the two enſuing treatiſes, ſince the title pages give a ſufficient hint of the noble author's main ſcope and chief deſign. I ſhall only ſay, that the firſt treatiſe effectually performs what has not been as yet attempted, by anſwering a very conſiderable objection againſt the doctrine of the corpuſcularian philoſophers; namely, that, which is taken from what we call ſpecific medicines, their virtues and operations being hitherto judged by ſeveral of the learnedeſt ſort wholly irreconcileable to the principles of the new philoſophy; whereby he gratifieth, not only the curioſity of ſpeculative philoſophers, but does likewiſe a notable piece of ſervice to all phyſicians, uſhering in here and there ſuch notions, as may be the principles of a ſure and eaſy practice; yea, and enable them too, to give a good account of their own receipts; I mean of thoſe, that contain ſpecific medicines, whoſe virtues hitherto we could not deſcribe to our patients, but by ſaying they did work we knew not how, or by ſome ſpecific, that is by ſome occult or hidden quality. The ſecond treatiſe, which is an invitation to the uſe of ſimple medicines, is of ſuch a general uſe, that mankind is much indebted to this noble author for it: it is ſo well grounded both upon reaſon and experience, that this, as well as the forementioned diſcourſe, does fully anſwer the great repute of the author, both at home and abroad, where he is commonly ſtiled *the Engliſh philoſopher*.

OF THE
Reconcileableneſs of SPECIFIC MEDICINES
TO THE
Corpuſcular PHILOSOPHY.

The INTRODUCTION.

To my learned Friend Dr. *F.*

SIR,

PErceiving, by our late conference, that the thing, which moſt alienates you from the corpuſcular philoſophy, is an objection drawn from your own profeſſion and experience; namely, that the ſpecific virtues of medicines are not reconcileable to it; my unwillingneſs, that an hypotheſis I am ſo kind to, as I am to the mechanical, ſhould continue under the disfavour of a perſon I ſo much eſteem, as I do Dr. *F.* makes me venture to offer you the annexed paper, though it be but an inlargement of a diſmembered part of what I long ſince, to gratify a friend, noted about the origin or production of occult qualities. For though I pretend not, that this trifle ſhould ſatiſfy a man of your judgment and learning, yet it may perhaps ſerve to keep you from thinking it impoſſible, that a ſkilful pen may be able quite to ſurmount thoſe difficulties, that ſo bad a pen as mine is of capable of leſſening.

A paper belonging to the writings about the mechanical origin of qualities.

AMONG the ſeveral kinds of occult qualities, that, which is afforded by the ſpecific virtues of medicines, is not here to be pretermitted: for theſe qualities do not only, like other hidden ones, invite our curioſity, but concern our health, and may hereafter (if I miſtake not) appear to be of much greater importance, than as yet they are commonly thought. However, it may be worth while to take ſome notice of them in this place, if it were but becauſe divers learned phyſicians do, as ſome of them owned to me, reject or disfavour the corpuſcular philoſophy upon this account, that they think it cannot be reconciled to the virtues of ſpecific remedies, or at leaſt cannot, either in a particular, or in a general way, give any tolerable account of them.

I FIND three ſorts of qualities mentioned in the books of phyſicians, under the notion of ſpecific virtues; for by ſome a medicine is ſaid to have a ſpecific faculty, becauſe it is eminently and peculiarly friendly to this or that particular part of the body, as the heart, the brain, the eye, *&c.* by others it is ſaid, by a ſpecific power, to attract and evacuate ſome determinate humour, as choler, phlegm, *&c.* But the moſt uſual account, upon which a medicine is ſaid to be ſpecific, is, that it has the virtue to cure, by ſome hidden property, this or that particular diſeaſe, as a pleuriſy, an aſthma, the cholick, the dropſy, *&c.* And this being the principal and moſt common ſenſe, in which the word ſpecific is employed by phyſicians, I ſhall ordinarily make uſe of it, in that ſenſe, in the following diſcourſe, but yet without ſo confining myſelf to it, as not to conſider it in the two other ſenſes, when occaſion ſhall require.

BUT before I deſcend to particular conſiderations, it will not be amiſs to obviate miſtakes, by declaring in what ſenſe, in this paper, I ſhall employ the term ſpecific medicine, eſpecially in the laſt of the three aforementioned acceptions.

I DO not then by a ſpecific underſtand a medicine, that will cure the diſeaſe it is good for infallibly, and in all perſons, that take it; for I confeſs I never yet met with any ſuch remedy; nor do I by ſpecific underſtand a medicine, that, almoſt like a charm, works only by ſome latent and unaccountable property, without the aſſiſtance of any known quality, as purgative, diuretic, ſudorific, *&c.* to be found in other medicines: but by ſpecific I mean, in this diſcourſe, ſuch a medicine, as very often, if not moſt commonly, does very conſiderably, and better than ordinary medicines, relieve the patient, whether by quite curing, or much leſſening his diſeaſe, and which acts principally upon the account of ſome property or peculiar virtue; ſo that if it have any manifeſt quality, that is friendly, yet the good it does is greater, than can be aſcribed to the degree it has of that manifeſt quality, as hot, cold, bitter, ſudorific, *&c.*

THERE are two grand queſtions, that may be propoſed about the ſpecific virtue aſcribed to medicines: the firſt is, whether there be really any ſuch? and the ſecond, whether, if there be, the mechanical hypotheſis can be accommodated to them?

THE former of theſe queſtions may admit of a double ſenſe; for it may be propoſed, with reſpect either to the preſent meaſure of our knowledge, or to thoſe further attainments, that, in future times, men may arrive at.

In the latter of theſe ſenſes, (to diſpatch firſt the conſideration of that) I ſhall not preſume to maintain, without reſtriction, either part of the queſtion: for I do not only hope, but am apt to think, that in time the induſtry and ſagacity of men will be able to diſcover intelligible cauſes of moſt of thoſe qualities, that now paſs for occult, and among them of many of the ſpecific virtues aſcribed to medicines. And yet, on the other ſide, I much fear, that men will not be ſucceſsful in tracing out the true and immediate cauſes of thoſe good effects of ſome remedies, that depend upon ſuch fine and uncommon textures, and ſuch latent and oddly guided motions, as fall not under our ſenſes, though perhaps aſſiſted by inſtruments: which conjecture will appear the leſs improbable, if we conſider thoſe admirable *idioſyncraſiæ*, or peculiarities of diſpoſition, whereof the books of eminent writers afford us many inſtances, to whoſe number I could, upon my own obſervation, add ſeveral, if I thought it needful. And though I am not ignorant, that ſome of theſe may be plauſibly accounted for, as that of ſome men's averſion to cheeſe, or to cats; yet I do not think, that the like explications can be extended to ſome others, that might be named, if it were here pertinent to diſcuſs that throughly.

As to the former ſenſe of the queſtion lately propounded, I confeſs myſelf very inclinable to the affirmative, as far as I can judge by thoſe writings of phyſicians I have had occaſion to peruſe: which limitation I add, becauſe I would not derogate from the knowledge of particular perſons, who, in ſo learned and inquiſitive an age, may be arrived at far greater attainments, than thoſe phyſicians have done, that have entertained the public about the occult and ſpecific qualities of medicines.

I know there have been, and ſtill are, dogmatical phyſicians, that upon the principles, as they pretend, of the ſchool-philoſophy, reject all medicinal virtues, that they think not reducible to manifeſt qualities: but of ſuch *Galen* ſomewhere juſtly complains, that they either deny matters of fact, or aſſign very incompetent cauſes of the effects they pretend to explain; and, for my part, I am ſo far from believing theſe men capable of giving ſufficient reaſons of the more hidden properties of medicines, that I am not apt to think them able, by their principles, to give clear and particular explications even of the more eaſy and familiar virtues of ſimples.

I am therefore diſpoſed to think, that, in the ſenſe formerly delivered of the term ſpecific medicines, there are ſome remedies, that deſerve that name.

To this opinion I have been led by ſeveral reaſons. And firſt, (to begin with the leaſt weighty) it has the ſuffrage of many learned phyſicians, both antient and modern, and particularly that of *Galen* himſelf, in ſeveral places of his works. And I remember, that treating of a ſpecific remedy againſt the biting of a mad dog, which virtue he aſcribes to an occult quality, or, as he ſpeaks, to the propriety of the whole ſubſtance, he takes occaſion to promiſe, that he would write a book of things, that operate upon that acccount: which book, if it had eſcaped with his other works (for he elſewhere cites it as having written it) would probably have furniſhed us with ſeveral things to ſtrengthen our opinion. And though in matters philoſophical I am little ſwayed by mere authority; yet the concurrent ſuffrage of many eminent phyſicians may, in this controverſy, be the more conſiderable, becauſe moſt of them, being noted practitioners, had opportunity to obſerve, whether or no any remedies deſerved the name of ſpecifics: and their teſtimony is, in our caſe, the more to be regarded, becauſe phyſicians, eſpecially famous ones, are not wont to be willing to acknowledge, that there are effects, which fall under the cogniſance of their art, whereof they cannot give the cauſes.

Galen. de Simpl. Medicam. Fac. lib. 11.

My next inducement to admit ſpecifics, is founded upon parity of reaſon: for it is manifeſt, that there are divers formidable maladies, that are produced by inconſiderable quantities of poiſons, that have not been diſcovered to produce ſuch great and diſmal effects by any manifeſt quality, whether firſt, ſecond or third, as medical authors (I doubt not over accurately) diſtinguiſh them.

On this occaſion I ſhall add a very odd accident, about which I was adviſed with by an expert oculiſt, very ſoon after it happened; the caſe was this: a man lying ſomewhat long in bed in the morning, and chancing, as he lay upon his back, to caſt up his eyes to the teſter, ſaw a great ſpider, that ſtood ſtill juſt over his face. Wherefore having reproached his wife, who happened to be in the room, with groſs negligence, ſhe took a broom, and ſtruck it upon the upper part of the teſter, to beat down the ſpider; but the animal held ſo faſt with his feet, that ſhe miſſed her aim, and he, whether frighted or irritated by this rude ſhake, let fall upon the man, that was ſtaring at it to ſee what would happen, a drop of liquor, that lighted directly upon one of his open eyes: but finding no heat nor ſharpneſs enſue, but rather a very ſenſible coldneſs, he made nothing of it, but roſe and put on his clothes; but preſently after, happening to rub with his finger the other eye, he was ſadly ſurprized to find himſelf ſuddenly benighted; and calling for aſſiſtance he found, that the eye, which the ſpider had let fall ſomething on, though no change were noted in it by the by-ſtanders, was totally deprived of ſight. Upon which ſcore he repaired to the above-mentioned oculiſt; but whether he afterwards recovered his ſight or no, I cannot tell; all the endeavours the oculiſt and I employed to find out his lodging (to which it ſeems he had left a wrong direction) having been fruitleſs. This brought into my mind, that I had ſometimes wondered to ſee, how much more quickly ſpiders will kill flies, than the cutting off their heads, or running them quite through with pins or needles will do.

BUT to return to what I was ſaying, of the great miſchief done to human bodies by very ſmall quantities of poiſon, methinks one may thence argue, that it ſeems not improbable, that appropriated medicines, eſpecially when adminiſtred in greater quantity, may produce very notable changes in the human body to the advantage of it. But on this occaſion I expect to be told, that it is much more eaſy to do harm than good, and I confeſs it is ſo in the general; but yet, in the particular caſe before us, I conſider, that ſome poiſons, that produce ſuch dreadful ſymptoms in the body, are frequently cured by their appropriated antidotes, which therefore muſt have a ſanative power great enough, with the help but of the ordinary concourſe of nature, to ſurmount the efficacy of the venomous matter. To which I ſhall add this more familiar inſtance, that as perfumes do often enough produce various, and ſometimes frightful ſymptoms, in many hyſterical women; ſo the fumes of the burnt feathers of patridges, wood-cocks, *&c.* do frequently cure the fit in as little time, as the ſweet ſmell procured it. And I have often found the ſmell of ſtrong ſpirit of harts-horn, or of ſal-armoniac, recover ſuch women in far leſs time, than the fragrant odours employed to make them ſick.

THE third and principal inducement I had, to think there are ſpecific remedies, is from experience. I might urge, on this occaſion, the teſtimony of *Galen*, who tells us more than once, that he himſelf therefore confided in the aſhes of burnt craw-fiſhes, for the cure of the biting of a mad dog, becauſe never any of thoſe, that took it, died. And to annex that upon the bye, for the uſefulneſs of it, he adds, that though the effect of theſe aſhes be admirable, even when given alone, yet their virtue may be increaſed, by adding to ten parts of burnt craw-fiſhes five of gentian and one of frankincenſe. And the great virtue of theſe burnt ſhell-fiſhes I find to have been taken notice of ſome ages before *Galen*; *Dioſcorides* much commending them againſt the ſame diſeaſe, that the *Pergamenian* does.

Galen *de ſimpl. Med. Fac. lib.* 11.

I SHALL in this place purpoſely forbear to mention ſuch medicines, as, though by divers learned phyſicians commended as ſpecificks, are yet by others much queſtioned, if not flatly denied to be ſo; ſince it may be more proper, and may perhaps ſuffice, to mention two or three, whoſe efficacy is more notorious.

IT is known, by almoſt daily experience, in *Italy* and divers other hot countries, that though the ſtings of ſcorpions oftentimes produce very acute pains, and formidable ſymptoms, yet the miſchief is eaſily remedied, either by preſently cruſhing the body of the ſcorpion upon the hurt, or by anointing the part affected with oil of ſcorpions, (for that reaſon to be almoſt every where found,) which being made by ſuffocating thoſe inſects in common oil, and keeping it long in the ſun, the liquor does not at all appear to have any manifeſt quality, to which its ſanative efficacy may be aſcribed.

THE bitings of thoſe ſerpents, which, for the noiſe they are wont to make with a kind of empty bladders in their tails, the Engliſh call rattle-ſnakes, are counted much more poiſonous and dangerous, than the ſtings of ſcorpions; of which I remember a learned eye-witneſs, that lived divers years in *Virginia*, where they much abound, related to me a very ſtrange inſtance, which I cannot now ſtay to ſet down: and yet the Engliſh planters, when they have the misfortune to be bitten by theſe ſerpents, are wont to cure themſelves very happily by the uſe of that plant, which from its effects, and the place it grows in, is well known by the name of Virginia ſnake-weed, [or *ſerpentaria Virginiana.*]

THAT the Peruvian bark, commonly called here in *England* the Jeſuits powder, is a ſpecific againſt agues, particularly quartans, divers learned phyſicians not only grant but aſſert; and I remember the juſtly famous Dr. *Willis* gave me this character of it in private diſcourſe, (not without taking notice, that ſome decried it,) it is the nobleſt medicine we (meaning the phyſicians) know. But though I will not diſpute, whether it be ſo certain and ſafe a ſpecific for agues, as it is believed by divers eminent doctors; yet I think it can ſcarce be denied to be a ſpecific medicine to ſtop the fits of agues, (in the notion of ſpecific remedies formerly delivered) ſince it does that more effectually, than the generality of phyſicians, for many ages, were wont to do with their other antifebrile medicines.

I MIGHT here tell you, that I have myſelf ſeen a ſtone, whoſe efficacy in ſtopping hemorrhagees invited my wonder; and another, which performed extraordinary things in more than one diſtemper, though I could not perceive, that either of them did theſe things by any manifeſt quality. And I might here add ſome other particulars, that may be borrowed from experience, in favour of our opinion; but that it is like they will be more properly alledged hereafter, in ſome places of the remaining part of our diſcourſe.

I KNOW thoſe, that have rejected ſpecific medicines, have confidently urged three plauſible arguments againſt them. For ſome phyſicians deny there are any effects of medicines ſo conſiderable, as to make them deſerve the name of ſpecific; others would probably allow, that experience favours our opinion, if they did not think the way of a ſpecific medicine's operating muſt be inexplicable, and conſequently ought not to be admitted by phyſicians; and others again (being of ſentiments very differing from theſe) will allow them to be very efficacious, but endeavour to derive their whole efficacy from manifeſt

manifeſt qualities, as heat, cold, tenuity of parts, faculty of making large evacuations by vomit, ſiege, *&c.*

But theſe objections will be more opportunely conſidered in due places; only there is one argument, that may be objected by the deniers of ſpecific remedies, which I confeſs is ſo ſpecious, as to deſerve to be particularly examined in this place, leſt it ſhould, if unremoved, beget too ſtrong a prejudice againſt a great part of the enſuing diſcourſe. For it may be ſaid, that a medicine taken in at the mouth muſt in the ſtomach and guts be at leaſt very much changed by digeſtion and the aliments it meets with there, and a good part of it will be proſcribed among excrements: that, after it has paſſed out of the ſtomach, it muſt meet with divers ſtrainers of differing textures, which will probably ſtop all or moſt of the medicinal corpuſcles, that would pervade them: and that if any ſhall be ſo lucky, or ſo penetrating, as to ſurmount all theſe obſtacles, they will probably either be aſſimilated unto the ſubſtance of the body, or quite changed by the parts they will be fain to combine with there: or, if yet any ſhould be able ſo obſtinately to retain their priſtine nature, they will in all likelihood be too few to have any conſiderable operation upon the body. But to this plauſible objection I have ſeveral things to oppoſe by way of anſwer.

1. And firſt I may repreſent, that divers ſpecific medicines, as ſome ointments, plaiſters, pultis's, amulets, pericarpia, *&c.* being outwardly applied, their corpuſcles can get into the maſs of blood without paſſing through the ſtomach, and conſequently are not concerned in the propoſed objection.

2. Against moſt of the Galenical phyſicians, that are wont to urge the formerly propoſed objection, I ſee not, why one may not argue *ad hominem*, by putting them in mind, that the ſame difficulties for the main, or others not inferior, may be alledged againſt a common opinion of their own: for ſince they believe, that purgatives, cordials, diaphoreticks, beſides cephalicks, hepaticks, and ſome other ſorts of medicines, do contemperate and ſweeten the blood, and uſefully affect the newly mentioned ſtable parts; and ſince theſe medicines act not by naked qualities, but by ſmall particles of their own ſubſtance, if they can give us an intelligible account of the ingreſs of theſe particles in conſiderable numbers into the receſſes of the body, without being diſpoiled of their particular virtues, they will at the ſame time inſtruct us, how to anſwer the objection they urge againſt us.

3. And in regard the generality of phyſicians hold, that milk and urine were materially in the maſs of blood, and are ſeparated from it by the breaſts and kidneys, I think one may by experience ſhew the invalidity of their ratiocination againſt ſpecificks: for it is obvious to obſerve, and I have ſeveral times done it myſelf, that rhubarb will (perhaps for many hours) tinge the urine of thoſe, that take any conſiderable doſe of it. And in ſome of our Engliſh American colonies there grows a fruit, which the planters call the prickled pear, whoſe inward ſubſtance is exceeding red, and whoſe being pleaſant in taſte as well as colour frequently invites eaters; but its juice is of ſo penetrating a nature, that it paſſes from the ſtomach into the bladder, and then into the chamber-pot, with ſo little loſs of its redneſs, that ſtrangers are wont to be ſurprized and frightned at it, as thinking this unknown fruit had made them void bloody urine, if not blood rather than urine. This is a known thing among thoſe, that have dwelt in our ſouthern plantations, and has been affirmed to me by unſuſpected eye-witneſſes, and among them by a famous phyſician. As for milk, the great *Hippocrates* himſelf informs us, that if a woman, or a ſhe-goat, take elaterium, the cathartic virtue paſſes into the milk, and will purge the child that drinks it: and I remember, that having occaſion to make ſome ſtay, in the ſpring or beginning of ſummer, in the confines of Switzerland and Savoy, I had the opportunity to obſerve this odd phænomenon; that when the cows in that diſtrict fed, as they would in that ſeaſon plentifully do, upon a certain weed, ſaid to be a kind of wild garlick, that grew copiouſly in the paſtures, the very butter made of their milk had ſo rank a taſte of the herb, that though I was not, yet divers other ſtrangers were, thereby diverted from eating of it, though otherwiſe freſh and good. And I remember too, that having paſſed a winter on the ſea-coaſt of the county of *Cork* in *Ireland*, I found it a known obſervation, that a ſort of greedy ſea-fowl, whoſe name comes not now into my mind, living almoſt wholly upon fiſh, (upon whoſe ſhoals I have ſometimes wondered to ſee ſuch a multitude of ravenous fowls attending) they acquire a taſte, that makes ſome pleaſantly queſtion, whether the food they afford be to be reputed fleſh or fiſh. But how conſtantly the particles of divers bodies may retain their nature in all the digeſtion and ſtrainers they paſs through, I have more amply diſcourſed in another tract, *About the concealments and diſguiſes of ſeminal principles*; and I preſume I have here ſaid enough, to allow me to proceed to the fourth part of my anſwer.

4. I consider then, in the laſt place, that whereas it is objected, that ſo ſmall a quantity of the matter of a ſpecific, as is able to retain its nature, when it arrives at the part it ſhould work on, muſt have little or no power left to relieve it; this difficulty will not much ſtagger thoſe, that know, how unſafe it is to meaſure the power, that natural agents may have to work upon ſuch an engine, as the human body, by their bulk, rather than by their ſubtilty and activity. A ſober gentleman, that was governor of a colony in the torrid zone, and commanded a warlike Engliſh veſſel, that ſailed up very far in the great river of *Gambia* or *Gambra* in *Africk*, and ſtaid there ſome time to trade with the Negroes of the inland country, being in-

quired of by me, among other things, about the poiſons, that are ſaid to be extraordinarily powerful in the parts he came from; he anſwered me, that the Blacks had a poiſon, that was, though ſomewhat ſlow, yet very mortal, in ſo ſmall a doſe, that it was uſual for them to hide enough of it to kill a man under one of their nails, which they wear ſomewhat long; whence they would drop it ſo dexterouſly into the drink, or milk, or broth, or other liquid aliment of thoſe they owe a ſpite to, that it is ſcarce poſſible for a ſtranger to be watchful enough to prevent it. For which reaſon, as he told me, though he ſometimes eat with their petty princes or governors at the ſame table, yet he would never eat out of the ſame diſh, nor drink out of the ſame cups with any of them. He added, that in another part of *Africa*, a famous knight, who commanded the Engliſh there, and lately died a ſhip-board in his way home, was ſo poiſoned at a parting treat by a young Negroe woman of quality, whom he had enjoyed and declined to take with him, according to his promiſe, into *Europe*. And though my relator early gave him notice of what he ſuſpected to be the cauſe of this indiſpoſition, and engaged him thereupon to take antidotes, and cordials, as treacle, *&c.* yet his languiſhing diſtemper ſtill increaſed, till it killed him.

I COULD name a vegetable ſubſtance growing in *Europe*, and perhaps not far from hence, which though ſome empiricks employ as a medicine, is ſo violently operative, that a learned and famous modern phyſician relates, that no more than half a grain would work ſo violently, as to cauſe very dangerous hypercatharſes, of which though he remedied ſome, yet he was not able to keep all from being mortal. And becauſe many ingenious men deny, that our Engliſh vipers are poiſonous, I ſhall add in favour of the argument, that I have been enforcing, that I know a young man, who having been bitten by an Engliſh viper, which he too raſhly laid hold on, though the tooth pricked but his hand, yet the venom conveyed by ſo ſmall a hurt, which perhaps equalled not in quantity the hundredth part of a pin's head, quickly produced in him the bad ſymptoms, that uſually follow the biting of that ſerpent; and among others (for I particularly aſked him about that) a violent vomiting of ill-conditioned ſtuff. I know alſo a perſon, that practiſed phyſic in the iſle of *Iava*, where ſcorpions are held to be more venomous than in *Italy*, who having, after he had drank ſomewhat freely, provoked, and been ſtung by, a ſcorpion, though the hurt was but in his thumb, and was ſo ſmall, that I could not perceive the leaſt ſcar it had left, that it put him preſently to ſuch violent tortures, for ſome hours, till he had procured ſpecific remedies, that he looked upon himſelf a dead man; and felt ſo raging a heat within, that he thought (to uſe his own expreſſion) that hell-fire was got into his body. Nor is it only by mere poiſons, that a human body may be greatly affected, though the agent be but very inconſiderable for bulk and weight; for we ſee, that divers women, otherwiſe ſtrong and healthy, will be caſt into ſwooning fits, and perhaps will complain of ſuffocation, and be put into convulſive motions, by the fragrant odours of muſk or civet; though if all the effluvia, that cauſe theſe ſymptoms, were reduced into one aggregate, this would not probably amount to a hundredth, nor perhaps to a thouſandth part of a grain. And I have oftentimes ſpeedily ſuppreſſed ſuch fits by the odour of the volatiſe ſalts, hartſhorn, ſal armoniac, or the like, or of diſtilled ſpirits abounding with ſuch ſalts; though perhaps all the particles, that actually relieved the patient, and calmed theſe frightful ſymptoms, if packed together, would not have equalled, either in bigneſs or in weight, the tenth, not to ſay the fifteenth, or the hundredth part of a grain of muſtard-ſeed. And as for inward remedies, it is vulgarly known, that in the infuſion of crocus metallorum, the corpuſcles, that render the liquor vehemently vomitive and purgative, are ſo very minute, that great proportions of wine, or other vehicles, may be ſtrongly impregnated with them, without any ſenſible diminution of the body, that parts with them. And of this we have a not leſs, if not more, conſiderable inſtance, when quickſilver is decocted or long infuſed in common water. For *Helmont* obſerves, that though the liquor be not altered in colour, or taſte, nor the quickſilver at all ſenſibly changed, nay, nor grown any thing lighter in a balance; yet the liquor does, by means of theſe inſenſible and unponderable effluxes of the quickſilver, acquire a notable virtue againſt worms; for which purpoſe, not only *Helmont*, but before him that experienced chymiſt *Hartman*, and another eminent writer, extol this medicine. And, on this occaſion, I remember, that a fine boy, born to be heir to a very illuſtrious family, falling into a dangerous fever, which was judged to proceed from worms or verminous matter; a famous and experienced phyſician, that treated him, confeſſed to me, that he was out of hopes of him; becauſe the child having been bred to have his will, and tired with unſucceſsful remedies, was ſo obſtinate and careful in refuſing to take any thing, that ſmelled or reliſhed of a medicine, that he forbore, in ſpite of all the art uſed to deceive him, even to drink any thing but ſmall beer. Whereupon I perſwaded both the doctor, and the lord, whoſe ſon the child was, to impregnate his ſmall beer with mercurial particles, by frequently ſhaking it with good quickſilver in it; by which means the patient perceiving no change of colour or taſte in the drink, ſwallowed it greedily, and through the bleſſing of God was ſoon after reſtored to a health, which the parties concerned aſcribed to the mercurial remedy.

I SHOULD condemn myſelf for having beſtowed ſo many words upon one objection, but that I hope the anſwer given to it in this place will facilitate and ſhorten ſeveral things relating to my preſent ſubject, ſpecific medicines; about which I ſhall now proceed to offer my thoughts in ſome propoſitions, and ſhort diſcourſes upon them.

HAVING now diſpatched the firſt of the two formerly propoſed inquiries, I proceed to the ſecond; namely, whether the mechanical hypotheſis can be accommodated to ſpecific medicines, ſo as that they may be either intelligibly explicated by it, or at leaſt ſhewn to be reconcileable to it? I preſume you will eaſily believe, that there are few writers more inclinable, than I am, to confeſs the dimneſs of our knowledge, and the obſcurity of many things in nature; or that are more forward, than I, to grant, that many of the operations of ſpecifick medicines are to be reckoned among thoſe abſtruſe things, whereof nature ſeems to affect the concealment: But notwithſtanding this, when I conſider, how comprehenſive and fertile the principles of the corpuſcular philoſophy are, I cannot deſpair, but that it will be found, that divers of the effects of theſe medicines may be, in a general way, explicated by them, and not any will appear inconſiſtent with them. This I deſire may be here taken notice of once for all, that, retaining the ſcope of the following diſcourſe ſtill in your memory, you may not think it ſtrange, that I content myſelf, on moſt occaſions, to give in general poſſible explications, and to ſhew, that ſpecific medicines may operate on ſome ſuch account as I propoſe, without affirming, that they certainly do ſo. I obſerved ſoon after the beginning of this paper, that there were three ſorts of virtues, to which phyſicians (though not unanimouſly) have given this title of ſpecific; namely, ſuch as evacuate ſome particular humour, ſuch as are peculiarly friendly to this or that part of the human body, and ſuch as in an unknown way cure or much leſſen this or that determinate diſeaſe. But yet I ſhall now apply my diſcourſe peculiarly to the laſt ſort of theſe medicines, as being both more conſiderable in itſelf, and the chief ſubject intended in preſent diſcourſe; giving nevertheleſs, as occaſion ſerves, ſuch additional hints and obſervations, as may make the reflections belonging to this third ſort of ſpecificks, eaſily applicable, *mutatis mutandis*, to the other two.

AND I ſhall begin with laying here for a foundation, what I have in another treatiſe had occaſion to deliver and make out; namely, that a living human body is not to be looked upon as a mere ſtatue, or a mere congeries of the materials it is compoſed of, fleſh, blood, bones, fat, nerves, veins, arteries, &c. but an admirably framed engine, conſiſting of ſtable, liquid, and pneumatic ſubſtances, ſo exquiſitely adapted to their reſpective functions and uſes, that oftentimes the effects of an agent upon it are not to be meaſured ſo much by the power of that agent conſidered in itſelf, as by the effects, that are conſequently produced by the action of the parts of the living engine itſelf upon one another.

THIS premiſed, I conſider, that there is no need to grant, that the operations of all ſpecifics, or of the ſame in differing diſeaſes, muſt be of one kind; but that differing ſpecifics may operate in ſeveral manners, and ſome by one of theſe ways may oppugn ſuch a diſeaſe, and others may do good againſt ſuch another. And of theſe general ways I ſhall briefly propoſe ſix or ſeven, that now occur to my thoughts; having firſt given you this important caution, that the ſpecific remedy does not commonly (though ſometimes it may) relieve the patient by this or that ſingle way of operating, but by a concurrence of two or more, that, as it were, join their forces to produce the deſired effect.

PROPOSITION I.

And firſt, ſometimes the ſpecific medicine may cure by diſcuſſing or reſolving the morbific matter, and thereby making it fit for expulſion by the greater common ſhores of the body, and the pores of the ſkin.

IT is known, that many diſeaſes, and thoſe oftentimes ſtubborn and chronical, proceed from certain tough or viſcous humours, that obſtruct the paſſages, whereby the blood ſhould circulate, or other uſeful liquors be tranſmitted: and theſe peccant humours are oftentimes ſo viſcid and obſtinate, that ordinary remedies will do little or no good upon them, And yet a ſpecific may, by the ſmalneſs and congruous figure of ſome of its corpuſcles, get through the pores into the receſſes of this ſtubborn matter; and by their ſolidity, figure, and agitation, promoted by the heat of the patient's body, may diſſolve and ruin the texture of the morbific matter, and render it capable of being proſcribed by nature, by urine, ſweat, or ſome other commodious and innocent evacuation. Thus the blood, or ſome other liquor of the body, being (to uſe the chymiſts phraſe) impregnated with the friendly and operative particles of the remedy, becomes an appropriated menſtruum in reference to the peccant matter; impregnated with ſal armoniac, becomes a menſtruum, that by degrees will diſſolve both copper and iron, as compact bodies as they are. I ſaid appropriated menſtruum, becauſe there is no ſufficient reaſon to ſuppoſe, that the menſtruum works by any manifeſt quality, as heat, moiſture, &c. or even by acidity itſelf; but rather by virtue of the fitneſs, which the ſhape, bulk, ſolidity, and other mechanical affections of its particles, concur to give it, to disjoin the parts of a body of ſuch a determinate texture. For, as I have in another paper amply ſhewn, there are far more menſtruums of diſtinct ſorts, than are commonly taken notice of; and the operations of theſe cannot ſafely be meaſured by the ſtrength of their manifeſt qualities, ſince it may ſeveral times happen, that a menſtruum, leſs acid or leſs ſtrongly taſted, may diſſolve this or that body, which another menſtruum, that ſeems far ſtronger, will not work on. Thus cold water will diſſolve the white of an egg, which pure ſpirit of wine will be ſo far from diſſolving, that it will coagulate it; [and ſo will ſpirit of ſalt and oil of vitriol itſelf.] Thus dephlegmed ſpirit of urine will readily diſſolve minute filings of copper, which ſpirit of vinegar will but ſlowly work upon; and yet this liquor will ſpeedily diſſolve crab's eyes, which ſpirit of urine will leave entire. Thus quickſilver, that is inſipid, will in the cold diſſolve gold, which *aqua fortis* itſelf, though aſſiſted by external heat, will not work upon; and yet *aqua fortis* will furiouſly beat aſunder the parts of iron, though quickſilver will not ſo much as adhere to its ſurface. And thus in fine (not to accumulate inſtances) common oil, that is ſo ſmooth upon the tongue, and will not diſſolve ſo much as an egg-ſhell, will diſſolve brimſtone, which yet will reſiſt *aqua fortis* itſelf, that will diſſolve almoſt all metals, beſide many hard ſtones and minerals. And I know a liquor, having more than once prepared it, which, though ſo weak, that one may drink a wine glaſs full of it pure without danger, will yet work on ſome very hard bodies, both ſtones and metals, in a way, that is not to be matched, among the highly corroſive menſtruums in uſe among chymiſts.

AND now ſuppoſing, that the active corpuſcles of a ſpecifick medicine, aſſociated with the blood or other vehicle they impregnate, may act upon the morbific matters they meet with in the body, after the manner of a menſtruum; ſuppoſing this, I ſay, we may hence illuſtrate ſeveral things, that have reference to the operation of ſpecific medicines.

1. AND we may hence derive a gueſs, why an appropriated medicine will perform things, which will not be done by another, whoſe manifeſt qualities ſeem to be the ſame for kind, and much ſtronger in degree. For menſtruums do not always act according to the degree of their acidity, or the like ſenſible quality; but according to the congruity of their corpuſcles to the pores of the body they are to diſſolve, and alſo oftentimes according to a fitneſs, that depends upon other mechanical affections of the acting liquor: and therefore phyſicians, as well as others, may eaſily miſtake in their argumentations *à majori ad minus, & à minori ad majus*. For the conſequence is not good to argue either thus; water, which is ſo ſtrengthleſs a liquor, will diſſolve gum Arabic; therefore highly rectified ſpirit of wine, which is a much more ſubtile and penetrating liquor, will do the ſame thing more powerfully; for experience ſhews it will not diſſolve it at all: or thus, ſtrong oil of vitriol is more corroſive in taſte, and will diſſolve many bodies, that *aqua fortis* will not; therefore it will alſo diſſolve ſilver as well as *aqua fortis*, the contrary of which is true. Nay it is not a good inference to argue thus; *aqua fortis* diſſolves ſilver by virtue of its acid ſpirits; therefore the more it abounds with theſe, the more potently it will diſſolve that metal: whereas I have elſewhere proved by experience, that if *aqua fortis* be made exceeding ſtrong, it will not work upon ſilver; but it will readily do it, if it be weakned by the addition of a fit quantity of common water.

To this I ſhall add, that the diſſolution of a body may depend, as well upon the peculiar texture of the body itſelf, as the manifeſt ſtrength of the menſtruum.

2dly. THE foregoing doctrine may ſuggeſt a reaſon, why a medicine, that does wonders in one diſeaſe, may do little or nothing in another, that ſome may think to be a kin to it, and, perhaps too, more eaſily ſuperable by it; for the preſumed cognation may not be ſo great, but that ſome diſſimilitude of texture in the morbific matters may make one of them unfit to be wrought upon by the ſame menſtruum, that diſſolves the other: and though pure ſpirit of wine will eaſily enough diſſolve *gummi Guajacum*, and alſo the little portion of reſinous matter, that are harboured in the pores and ſmall cavities of the wood; yet the ſame menſtruum will not work upon the wood itſelf of the tree, that affords thoſe ſoluble ſubſtances.

3. THIS may keep it from being thought ſtrange, that ſpecific medicines ſhould ſometimes fail of their uſual effects. For as the bodies of individual patients may differ very much, either according to their natural conſtitution, or to that, which they acquire by the diſeaſe, that diſtempers them, or on both thoſe accounts; ſo it ought not to ſeem ſtrange, that, in ſome ſick perſons among many, the congruity between the agent and patient ſhould be altered, either by ſome conſiderable change in the texture of the morbific matter, or by ſome notable alteration, that the corpuſcles of the medicine receive in their paſſage through the veſſels, by the admixture of ſome incongruous particles of the blood or other vehicle. Thus ſpirit of ſalt will, as I have tried, diſſolve copper, as ſpirit of nitre does: which notwithſtanding, though this laſt named liquor will diſſolve ſilver, yet if you mix with it ſpirit of ſalt, which, by the like operation of both upon copper, ſeems to be amicable to it, the ſpirit of nitre will no more be able to diſſolve ſilver as it could before.

4thly. OUR hypotheſis may alſo hint to us an anſwer to one of the main and moſt plauſible objections of the deniers of ſpecific medicines. For ſome of them aſk in a ſcornful way, how it is poſſible, that a medicine ſhould rove up and down in the maſs of blood, and, neglecting all other things, ſhould ſingle out and faſten upon the morbific matter men wiſh it ſhould proſcribe? For if the medicine acts by impregnating the blood, or ſome other liquor of the body, and turning it into a kind of menſtruum, it is very poſſible, both that the ſtrainers, through which the corpuſcles muſt paſs, may keep back the inconvenient parts of the vehicle; and (which is in our caſe more conſiderable) the menſtruum may be either appropriated to the peccant humour, as has been formerly declared, or elſe may at leaſt be qualified to reſolve

reſolve that more eaſily, than any other ſubſtance it meets with in the body. As if you take ſome bone-aſhes, and *Crocus Martis*, and ſaw-duſt, and powdered ſea-ſalt, and filings of gold, and blend all theſe together; if upon one half of this mixture you pour common water, it will not meddle with any other of the ingredients except the ſea-ſalt, which it will readily diſſolve: and if upon the other half of the ſame mixture you put a ſufficient quantity of quickſilver, and rub them together, this metalline liquor will neglect all the reſt of the ingredients, and the ſea-ſalt itſelf, and faſten upon the gold. And thoſe, that work in the Spaniſh gold-mines, inform us, that when they have well ground ſome ore, that contains gold and copper, beſides heterogeneous minerals, well heated quickſilver will take up the gold much ſooner and better, than it will the copper, ſcarce meddling with the latter, as long as there remains any not deſpicable quantity of the former to be wrought upon by it. And as for the ſuppoſed difficulty, that the medicine ſhould ferret out, if I may ſo ſpeak, the morbific matter, in what veſſel ſoever of the body it lies, this objection might have been conſiderable, before the diſcovery of the blood's circulation; but it is not ſo now, that we know, that things, that once get into the maſs of blood, are preſently whirled about with it, and may be conveyed by it even to ſmall veſſels lying in the remoteſt parts of the body.

5thly. And this prompts me to take notice, that our hypotheſis may help us to anſwer thoſe many learned phyſicians, that either reject, or at leaſt deſpiſe, moſt external remedies, eſpecially pericarpia, amulets, and appenſa, upon a ſuppoſition, both that they neither can furniſh the body they do but externally touch with any ſtore of medicinal particles; and, which is chiefly in this place to be conſidered, that being but external remedies, they muſt be very unable to do good in internal diſeaſes, eſpecially ſuch as are ſeated in parts remote from thoſe, which the medicine is applied to. But as to the former part of the objection, it will not be difficult to anſwer it to him, that has read what I have elſewhere written of the ſubtilty, numerouſneſs, and efficacy of effluviums. And we need but conſider, what plenty of particles, ſenſible to the noſtrils, are for a long time emitted by a ſmall quantity of ambergreaſe, or even of camphire (which is often externally uſed,) and the multitude of magnetical corpuſcles, that for many years conſtantly effluviate from a ſmall vigorous loadſtone, to think it poſſible, that even dry and ſtable bodies may afford ſufficient ſtore of effluvia to perform conſiderable things in ſo curiouſly framed an engine, as the human body is; where we ſee, that the odour of muſk or civet, for inſtance, may ſpeedily caſt divers perſons into fits, and the ſmell of caſtor or *aſſa fœtida*, and much more that of ſalt of harts-horn, or of ſal-armoniac, quickly relieve them. And as to the ſecond part of the objection, what I have elſewhere made out, and the beſt modern phyſicians grant, of the poroſity of the ſkin, ſhews, that it is very poſſible for the ſubtil effluvia of ſeveral bodies to get through the pores of the ſkin; and when they have once got admittance, ſo much as into the ſmaller veſſels, it is eaſy to conceive, how theſe may carry them into the greater, and conſequently into the maſs of blood, by whoſe circulation they may be readily conveyed to all the parts of the body, and among them to the ſeat of the diſeaſe; and perhaps, (to add that upon the bye,) the efficacy of theſe corpuſcles, that, if I may ſo ſpeak, get in at the key-hole, not at the door, may be the more conſiderable, becauſe they get preſently into the maſs of blood, without paſſing through thoſe digeſtions in the ſtomach and other parts, which oftentimes much weaken the vertue of medicines taken in at the mouth before they arrive at the blood.

The Eſſay of the Poroſity of animal bodies.

PROPOSITION II.

Sometimes a ſpecific medicine may mortify the over acid or other immoderate particles, that infeſt the maſs of blood, and deſtroy their coagulatory or other effects.

THOUGH I am not of their opinion, who of late are wont to impute almoſt all diſeaſes to acidity abounding in the blood and other liquors of the body, by whoſe intervention the ſtable parts alſo are offended; yet I readily grant, that a conſiderable number of diſtempers are, at leaſt in great part, produced either by acids themſelves, or by their bad effects or productions. Agreeably to which doctrine we may very probably conceive, that ſeveral maladies may be either quite cured, or much leſſened, by a ſpecific remedy, that abounds in corpuſcles fitted to mortify acids. This mortification may be effected by more than one way; and of theſe ways the chief, that now occur to my thoughts, are two.

For there are ſome bodies, that mortify or diſable acids by a poſitive hoſtility, if I may ſo term it; that is, by ſuch a contrariety, as is diſcernible by the taſte, and more by the viſible conflict and manifeſt tumult, that is produced, when they come to invade an acid. Of this ſort of mortifiers of acids are the moſt part of thoſe, that are called alcaliſate ſalts; whether fixt, as the lixivial ſalts of plants, or volatile, as the ſpirits and aſcending ſalts of urine, blood, hartſhorn, ſoot, *&c.* as may be exemplified, when any of theſe comes to be mingled with *aqua fortis*, ſpirit of ſalt, oil of vitriol, or the like acid liquors, by which, by the way, we may ſee, that thoſe Galeniſts miſtake, who aſcribe the virtues of ſpirit of hartſhorn, and of urine, only to their tenuity of parts, briſkneſs of motion, and the like affections, that they might not ſeem beholding to the chymiſts for ſo uſeful a notion, as that of the contrariety of acids and alcalies.

The other principal way, by which acids may be mortified or diſabled to bite, is by ſheathing them, if I may ſo expreſs it; for as a knife may be diſabled to cut, either by filing off or otherwiſe blunting its edge, or elſe by covering the blade with a ſheath fit for it, or by ſticking it into a loaf of bread, or the like body fit to receive and detain the whole blade; ſo an acid corpuſcle may loſe its power of cutting or pricking, either by having its figure ſpoiled by the action of a ſtrong and manifeſt alcali, or elſe by being, as it were, ſheathed in a porous body, though perhaps endowed with no taſte or any other manifeſt quality, by which one would think it contrary to the acid it diſables, as a file is to the edge of a knife. Of this way of mortifying acids chymical operations afford us many inſtances; as when *menium* deſtroys the acidity of ſpirit of vinegar, as I have found chalk will do that of *aqua fortis* itſelf; and *lapis calaminaris* very much leſſens, as well as alters, the acidity of ſpirit of ſalt, and even of ſpirit of nitre. And I the rather mention this mineral, both becauſe its qualities are leſs known to phyſicians and the generality of chymiſts, and becauſe it ſupplies me with an argument to prove, that acids may be, though I do not think they always are, rather ſheathed in, than deſtroyed, by the bodies, that ſilently mortify them; for, as *Glauber* has truly enough obſerved, acid ſpirits (as I have tried in ſome) may by force of fire be driven in diſtillation out of the *lapis calaminaris* very much dephlegmed, and ſtronger than before.

I know it may be here objected, that the mortification of acids is performed by a manifeſt quality, and therefore makes nothing for the favourers of ſpecific medicines; but to this I anſwer.

1. That the power of mortifying acids, eſpecially by ſheathing them, or, if you pleaſe, by abſorption of them, is none of thoſe qualities, whether firſt, ſecond, or third, that the former phyſicians took notice of in medicines; though the ſufficiency of theſe qualities, to cure diſeaſes, has been, and ſtill is, uſed by many, as a ground of denying the ſpecific virtues of remedies.

2. That I have often looked upon it as an unhappy miſtake and of ill conſequence, that ſo many learned modern phyſicians take it for granted, that if a medicine be endowed with a manifeſt quality, as acid or alcaliſate, the good it does, (and the like for the moſt part may be ſaid of the harm) may ſafely be aſcribed to that quality, that is, to its being of an acid, or elſe of an alcaliſate nature; whereas, in my poor judgement, there being a conſiderable diſparity, as various trials have aſſured me, between acid and acid, as likewiſe between alcali and alcali, it is fit to diſtinguiſh betwixt an acid, for inſtance, as meerly ſuch, and the peculiar modification, that may belong to that acid. Thus, though all acid menſtruums, that I know of, if they be well dephlegmed, will diſſolve copper; yet *aqua regis*, that will diſſolve not only that metal, but the much more cloſely compacted body of gold, will not at all diſſolve ſilver; as on the other ſide *aqua fortis*, as corroſive a menſtruum as it is, will not of itſelf diſſolve gold, but, if you give it a new modification, by adding to it common ſpirit of ſalt, which itſelf I have often found (whatever chymiſts think or have written to the contrary) will leave it entire, the *aqua fortis* will eaſily diſſolve that metal. Nay a different modification may not only make a diſparity between acid, but that, which, according to the received way of judging, ought to be called a contrariety: for ſpirit of ſalt will precipitate ſilver, which *aqua fortis* has diſſolved; and ſpirit of nitre, though one of the acideſt menſtruums we have, will not only precipitate an antimonical powder out of that odd ſubſtance, that chymiſts call butter of antimony, but will do it with a wonderful conflict, tumult, and efferveſcence; and yet this butter of antimony is ſo highly acid, that a little quantity of it, put into a conſiderable one of water, makes it ſo ſour, that many chymiſts call it *acetum philoſophorum*. And now, to apply theſe things to the lately propoſed objection, I deſire it may be remembered, that near the beginning of this letter I plainly intimated to you, that I did not deny, but that a ſpecific medicine may ſometimes be accompanied with, or even in part operate by a manifeſt quality; but that yet I thought the good effect was not due barely to the kind or degree of the manifeſt quality, but to ſomewhat ſuperadded, which gave it a ſpecific virtue againſt this or that particular diſeaſe. And ſuitably to this it may be ſaid, that as there are ſeveral kinds of acids, and of alcalies too, it is not every acid, that will be mortified by every alcali, and have its effects deſtroyed by it; which may be illuſtrated by this: that though, when copper is diſſolved in *aqua fortis*, it is poſſible, by the help of meer chalk ſkilfully applied, to make the menſtruum let go the corpuſcles of the metal; yet if upon ſuch a high coloured ſolution of copper you ſhall pour (as, to convince ſome ingenious men, I have purpoſely done) a due quantity of ſpirit of urine, or the like volatile alcali, though there will preſently enſue a great conflict and manifeſt ebullition, with noiſe and ſtore of bubbles, yet between theſe hoſtile ſalts a multitude of the acid corpuſcles of the *aqua fortis* will not be ſo mortified, as to let go the metal, but the ſolution, varying its colour, will have and keep a deeper one than before.

And when I conſider the differences, that a ſkilful obſerver may find between vinegar, allom, cryſtals of tartar, juice of lemons, juice of barbaries, the eſſential ſalts, (as chymiſts call them) of thoſe plants, that are ſour in taſte, to omit divers other acids; I am apt to think, that diſordered nature may have, in a diſeaſed body, produced acids of ſeveral ſorts, which are not particularly known to us; and that ſome of theſe may be of ſuch a nature, that none of our common alcalies, as ſuch, is able to mortify them, and which yet may be more mortified, at leaſt by the way of ſheathing, by ſome appropriated, or peculiarly modified corpuſcles of a ſpecific remedy; which may be illuſtrated by what is elſewhere obſerved, that though neither ſpirit of vinegar, nor ſpirit of ſalt, nor oil of vitriol itſelf, would, as far as I have tried, diſſolve a ſtone taken out of a man's body, yet ſpirit of nitre, (which does not diſſolve ſeveral bodies, that I have found diſſoluble in oil of vitriol) will readily work upon it, and thereby loſe its corroſiveneſs.

Before I leave this ſubject, it will not be amiſs to intimate a couple of things, that perhaps you will not think impertinent to it.

One of theſe is, that whereas I not long ago diſtinctly named acids themſelves, and their productions, I did it (not out of inadvertence, but) becauſe I think preternatural acids do not only diſaffect the body, whilſt they continue ſenſibly acid, but may, in divers caſes, be the cauſes of ſome diſtempers, whereof moſt men would think them more likely to be the remedies. For though acids be reputed to have an inciſive and reſolutive virtue, and therefore oxymel, and ſome other acetous medicines, are commended to cut tough phlegm, and ſpirit of vitriol is uſed for the ſame purpoſe, and to diſſolve coagulated blood; yet, as I am willing to grant this virtue unto acids, in ſome caſes, ſo there are others, wherein I much ſuſpect, that obſtructions, and conſequently the diſeaſes, that uſually attend obſtinate ones, may be occaſioned by acids, as they coagulate ſome fluids in the maſs of blood, that are diſpoſed to be thickened by them, and by that conſiſtence made unfit to paſs with the reſt of the circulating blood through the ſmaller veſſels and ſtrainers of the body, where upon that account they make obſtructions. This I ſhall exemplify by the coagulation, that I have made by ſome acid ſalts, as ſpirit of ſalt, of the white of an egg, eſpecially if, by beating, reduced to an aqueous conſiſtence. And the like coagulation may eaſily be effected in milk; which may not only be ſpeedily curdled with ſpirit of ſalt, but, as is known by bodies not chymically prepared, as rennet and juice of lemons. And experiments, purpoſely made, have ſhewn, that, if ſome acids be conveyed immediately into the maſs of blood, they will coagulate even that liquor, whilſt it continues in the veſſels of the yet living animals.

The other thing I lately told you I was to obſerve is, that though acid corpuſcles are thoſe, that modern phyſicians and chymiſts are wont to take notice of as hurtful, both in the blood and ſtable parts of the body, except the ſtomach, and perhaps ſome few neighbouring parts, as the ſpleen and pancreas; and though ſome ingenious men proceed ſo far, as to impute almoſt all diſeaſes to the bad effects of acids, yet I am very inclinable to think, that divers maladies and troubleſome ſymptoms proceed from corpuſcles, that, whether they be of a ſaline nature or not, are different from acids, properly ſo called: for I conſider, that there may be many bodies, which may, as it were, reſult from the combination of acids with other ſaline particles, that much alter their nature; as I have elſewhere noted, that ſpirit of ſalt will, with ſpirit of urine, compoſe a kind of ſal-armoniac; and ſpirit of nitre, with ſalt of tartar, diſſolved in common water, will concoagulate with it into ſalt-petre, (or a body exceeding like it) and the ſame ſpirit of nitre, or aqua fortis, with ſpirit of urine, or of blood, or the like, will afford a very fuſible ſalt, differing enough from what either of the ingredients was before their conjunction. And it is vulgarly known, that oil of vitriol, and oil of tartar *per deliquium*, do, by their coalition, produce *tartarum vitriolatum*, in which the acidity of the former and the alcaliſateneſs of the latter are very much infringed, a third body being by reſultancy produced, that differs much both from the former and the latter oil, or rather ſaline liquor. And when, beſides inſtances of this nature, I conſider, how many differing ſorts of corpuſcules ſo fruitful a principle as nature may have formed, that, without being acid, may yet have notable and hurtful effects upon the blood, or ſome particular ſolid part of the body; it ſeems probable to me, that there may be other qualities required to mortify or diſable theſe morbific corpuſcles, than a contrariety to acid ſalts; and conſequently, that a medicine, that affords corpuſcles peculiarly fitted to correct or enervate this particular ſort of hurtful ones, may deſerve the name of a ſpecific.

And here I further conſider, that as in the body there may be divers coagulations made by ſaline corpuſcles manifeſtly acid; ſo there may be others produced by corpuſcles, whether ſaline in taſte or no, that are not manifeſtly acid, but perhaps rather of a contrary nature; which obſervation being wont to be over-looked by phyſicians, and yet, in my opinion, of no ſmall importance, may deſerve to be a little the more carefully made out. I have ſometimes, for curioſity, made a liquor, that was not in taſte either acid or urinous; to which having put a moderate proportion of a diſtilled liquor, which itſelf was not in taſte either acid or urinous, or lixiviate, it would in a very ſhort time, perhaps in not many minutes, be coagulated into ſo conſiſtent a body, that, though the wide mouthed veſſel were held with the orifice downwards, nothing would fall out of it.

I have taught in another (unpubliſhed) paper, that if upon a certain ſolution (which I there ſhew how to make) one drop ſome ſpirit of urine, or another volatile alcali, there will preſently be produced a gelly, whoſe conſiſtence and colour may make it eaſily be taken for common ſtarch ready to be employed to ſtiffen linnen.

The like gelly, but more tranſparent, I have more than once made, without the help of any thing, that is ſenſibly acid or urinous.

I have alſo, to convince ſome virtuoſi, ſhewed them, ſomewhat to their ſurprize, a ſubſtance I had prepared without the help of urine, or any volatile alcali, (and ſometimes almoſt in a trice) that would in very few minutes coagulate above twice, if not thrice its weight of highly rectified and inflammable vinous ſpirit into a ſtable maſs.

And to ſhew you, that it is not requiſite, that a liquor be ſtrongly, or ſo much as ſenſibly acid to coagulate an animal ſubſtance, as I lately noted, that the ſpirit of ſalt did the white of an egg, I ſhall add, that well dephlegmed ſpirit of wine will do the ſame thing as well, if not better.

PROPOSITION III.

Sometimes the ſpecific medicine may help the patient, by precipitating the peccant matter out of the blood, or other liquor (of the body) that harbours it.

THOUGH precipitation be oftentimes a conſequent of the mortification of acids, or of alcalies, by corpuſcles of a contrary quality, yet I thought fit to ſay ſomething of it apart; becauſe I have obſerved that ſome acids and alcalies may be put together, without cauſing precipitation by their contrariety; and, on the other ſide, that divers precipitations may be produced, where there does not appear any hoſtility; though I know divers ingenious men, who think this effect itſelf a ſufficient argument, that the hoſtility of acids and alcalies muſt be the cauſe of it: but that ſhould not be taken for granted, but proved by collateral experiments, that do not ſuppoſe the truth of the hypotheſis itſelf. But to proceed to our examples; I know (and elſewhere mention) ſeveral urinous ſpirits, that I could mix with acid menſtruum, without making any manifeſt conflict or precipitation; and, on the other ſide, acids and alcalies, that will make a manifeſt conflict by their mutual creation; and yet, if they be mingled in a juſt proportion, will have, for the conſequent of their mixture, coalition inſtead of precipitation; as may be exemplified in certain mixtures of ſpirit of ſal-armoniac (made with ſalt of tartar, or pot-aſhes) and ſpirit of nitre or aqua fortis; and alſo when ſpirit of urine and ſpirit of ſalt, being mingled in a certain proportion, convene into corpuſcles for the making of ſal-armoniac, which the phlegm of thoſe liquors will keep ſwimming. But that, which makes moſt for my preſent purpoſe, is, that there may be precipitations, where, whatever may be ſuppoſed, it does not appear, that there is any tumult or contrariety; as when ſilver, being diſſolved in aqua fortis, and the menſtruum diluted with thirty or forty parts of diſtilled water, or of rain water, if clean plates of copper be immerſed in the ſolution, the metal will be very ſlowly precipitated out of it, in the form, not of a calx, conſiſting of metalline and ſaline parts, incorporated together, but, at leaſt at the beginning, in the form of pure ſhining ſcales of ſilver, almoſt like the white and glittering ſcales of ſome ſmall fiſhes. There is alſo a way, by which I have brought diſſolved gold to ſettle about a body, ſuſpended in the ſolution, in the form of a fine and high-coloured calx of pure gold. But you may eaſily ſee an inſtance of ſilent precipitation, if you do but rub a little either Roman or Dantzic vitriol upon the well-whetted blade of a knife, wetted with water or ſpittle; for you will have the ſteel, almoſt in a trice, overlaid with a reddiſh ſubſtance, which, by its colour and other ſigns, appears manifeſtly to be cupreous. And here I ſhall advertiſe you, that it is not only, as is wont to be ſuppoſed, out of ſolutions made with acids, that bodies may be thus precipitated; for, upon ſearch, I have found, that there are in nature precipitants, that are capable of ſilently precipitating ſome bodies diſſolved in urinous menſtruums, or others not acid. I know it may be ſuſpected, and that not without colour of reaſon, that ſuch precipitations may be dangerous, by producing heterogeneous corpuſcles in the blood, that may be too heavy or groſs to be evacuated; and I look upon this as a ſuſpicion, for whoſe reſolution it were fit to conſult experience; but in the mean time one may repreſent,

1. That though ſome inconvenience may happen from the bulk of the precipitated corpuſcles, yet that may be much inferior to the danger threatned by the over-active and hoſtile particles, that produced or fomented the diſeaſe.

2. That it is not neceſſary, that all concretions ſhould conſiſt of corpuſcles ſo bulky, as to be too big to be thrown out of the maſs of blood; for we ſee that ſtony matter, which, as the chymical analyſis of it ſhews, is of a very compounded nature, may be carried to all parts of the body. And I remember I knew a lady, who, a while before ſhe told me the ſtory, had a ſtone taken out of the lower part of her tongue. And phyſicians, that preſcribe great quantities of mineral waters, impregnated with iron, ſuch as I found thoſe of *Tunbridge* to be, and with ſulphur, ſuch as ſome of the *Bath* waters are, are wont to build their expectations of curing with them, upon a ſuppoſition, that they are carried into the maſs of blood, and conſequently to the innermoſt parts of the body.

3. That yet it is poſſible precipitations may be made of matters contained in the blood by medicines, that do not get into the maſs of it: as phyſicians give ſteel in ſubſtance ſometimes crude, as well as often times prepared, to mortiſy the acidities of the blood, though the metalline corpuſcles do not, for aught we know, paſs into the maſs of it, but are wrought upon by the matter, that in its circulation is thrown out of it into the ſtomach and guts, where their operation

on it is probably inferred from the blackneſs, that chalybeates are wont to give the excrements of the lower belly. And if they will have it, that prepared ſteel, for inſtance, calcined with ſulphur, gets through the pores of the bowels, or the extremities of the capillary veſſels, into the maſs of blood itſelf; it will be obvious to demand, why nature ſhould not be able to expel precipitated corpuſcles at the ſame paſſages, at which ſuch compounded concretions, as thoſe of ſulphur and metal, can get in.

4. That ſome may very ſpeciouſly pretend, that experience has been already conſulted about the expediency of employing precipitating medicines. For not to urge, that the learned and judicious *Sennertus* ſeems to intimate, that, in ſome caſes, the febrile matter may be ſurmounted by being precipitated out of the blood; there is a profeſſor of phyſic, who, though I cannot aſſent to ſome of his principles and doctrines, has delivered ſeveral conſiderable things about fermentation and fevers; and this profeſſor, by name *Kergerus*, very ſolemnly declares*, that for fourteen years he cured above a 1000 febricitants, without bleeding, purging or ſweating medicines, (to which he adds ſome other ſorts) by a ſingle precipitating remedy. I endeavoured to obtain from *Germany* an account of the truth of the matter of fact, but did not receive it; only I found, that a phyſician of this emperor's does, in a lately publiſhed book, declare himſelf inclined to believe it to be true.

I shall much the more eaſily be induced to think, that great and deſirable changes may be wrought in the fluid parts of the body by appropriated precipitants, if that be true, which is unanimouſly taught by a multitude of phyſicians, who impute many diſeaſes to the putrefaction of the blood and other liquors of the body. For, though certain reaſons oblige me to deſire you, not to aſk me any queſtions about the remedy I am going to ſpeak of, becauſe I muſt not yet anſwer them; yet I am willing you ſhould, on this occaſion, know hiſtorically, (what probably you will think ſtrange) that there is in *rerum natura* a certain ſubſtance, which is ſo powerful an enemy to putrefaction, that, when a few grains or drops of it were put into a conſiderable quantity of water, that had been kept till it ſtunk ſo ſtrongly and offenſively, that, if I had not known what it was, I ſhould have judged the ſmell to have proceeded from carrion; this medicinal liquor, I ſay, (for ſo I may call it) being diffuſed by agitation through this abominably ſtinking water, (which did not appear turbid to the eye) in ſo very ſmall a proportion, precipitated out of it a very little and light feculency, which being ſeparated, the reſt of the liquor was quite freed from all ſtink; nor did I obſerve, that the feculency itſelf had any; and, which is very notable, all this was done in a very few minutes, by a precipitant, whoſe taſte was not at all either bitter, or acid, or urinous, or lixivial: all which are circumſtances, that may afford good hints to ſpeculative and ſagacious inquirers.

Proposition IV.

Sometimes the ſpecific remedy may work, by peculiarly ſtrengthening and cheriſhing the heart, and by that means, or without it, the part affected.

THIS obſervation can ſcarce be made good, without entering into the controverſy, which, for its difficulty and importance, has perplexed divers modern phyſicians; whether there be any medicines, that have a ſympathy with the head, heart, liver, *&c.* and thereby deſerve the name of cephalic, cordial, or hepatic, *&c.* or, to ſpeak ſomewhat more clearly, whether there be any medicines, that, in a peculiar manner, do good to this or that particular internal part of the body. In this diſpute the affirmative part has been held, but I doubt upon ſlender grounds of reaſon, in moſt of the phyſic ſchools for ſeveral ages. But in our times, many do not only maintain the negative, but deride the opinion they have forſaken; for ſome of them object, in a triumphant ſtyle, that it is ridiculous to fancy ſuch a ſympathy betwixt a dead medicine, and the parts of a living body, as that the phyſician may ſend the drug, as it were, of an errand, to find out one in the dark, among a multitude of others, and do it good offices.

But notwithſtanding this, I think it very poſſible, that a medicine may ſo far reſpect a particular part, as, though not to be beneficial to that only, yet to be friendly to that, in a particular manner or degree; and this I conceive it may be, upon one or more of the accounts, that I ſhall briefly mention.

And firſt, when I conſider that the ſtable parts of the body, as the heart, brain, liver, kidneys, *&c.* have each its particular ſtructure,

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* *Ego ab anno 1549. in hunc diem per intregos 14 annos ultra mille febricitantes ſine venæſectione, ſine purgatione, ſine ſudoriferis, ſine diureticis, ſine alterantibus, ſine corroborantibus, ſine topicis, et ſiquid præterea unico fere medicamento præcipitante, Deo imprimis benedicente, curavi: non conſiderando, an febris ſit intermittens, an continua, an tertiana, vel quartana (quæ tamen difficilius curatur quam aliæ) nec expectata coctione, nec habita reſpectu ſexus, (ne puerperis quidem exceptis) ætatis, anni, temporis, vel aliarum circumſtantiarum: et quidem paucorum dierum ſpatio, ſine recidiva vel aliquo notabili incommodo, niſi ubi æger ipſe per incontinentiam de novo paroxyſmos provocarit.* Kergerus de Fermentatione, ſect. 3. cap. 3, p. mihi 250. “From the year of our Lord 1649. in the ſpace of 14 years “I cured above a thouſand febricitants, without bleeding, purging, or ſweating, by the help of a ſingle precipitating remedy, without any regard to the nature of the fevor, whether it were intermitting, or continued, whether “it were a tertian, or a quartan, which is harder to cure than any other; yea, without conſidering any other circumſtance either of time, place, ſex or age, and that in a very ſhort time, without any danger of relapſe, and “without any conſiderable trouble of the patient, if, through his own intemperance, he fell not into new fits again.”

ture, wherein it differs from others, and probably the fluid parts alſo, as blood, gall, lympha, *&c.* have their diſtinct textures; it ſeems not improbable to me, that the corpuſcles of a medicine diſſolved in the ſtomach, and carried to and fro by the liquors of the body, may, according to the determinate ſhape, ſize, ſtiffneſs, or flexibility, motion, *&c.* be much more fit to be detained by one part of the body, as the brain, the heart, *&c.* than by the reſt; and ſo, by lodging itſelf in its pores, or aſſociating with its fibres, may ſupply it with ſuch congruous particles, as it either does want, or, in caſe it do not, may by their congruity be of advantage to it, by re-eſtabliſhing or ſtrengthening the tone of it. And by this corroboration the part may be made able to reſiſt the hoſtilities of morbific matter, which phyſicians uſually obſerve to be wont, by the more vigorous parts, to be thrown upon the weakened or diſtempered ones; as is manifeſt in perſons, that are much ſubject to the gout, in whom oftentimes peccant humours are very apt, upon ſeveral occaſions, to be thrown off by the nobler parts, if they be robuſt, upon the frequently debilitated joints; on which ſcore the gout, if it be well managed, is, not irrationally, wont to be thought conducive to long life: and on this occaſion I remember, that I formerly knew a learned phyſician, who, though a great traveller, and, as ſuch, accuſtomed to great varieties in point of diet, had ſuch a peculiar indiſpoſition in his jaw, that though he could moderately drink wines of ſeveral ſorts without inconvenience, yet the drinking even of a very little brandy would ſoon after give him the tooth-ach, of which odd diſtemper he has ſometimes complained to me. But this upon the bye; for I muſt now proceed to illuſtrate and make probable, what I was ſaying of the poſſible fitneſs of ſome medicinal corpuſcles to aſſociate themſelves with thoſe of the part they are to befriend, by obſerving what happens in nutrition, eſpecially in that of ſucking-children; for in theſe one ſingle aliment, namely milk, does afford, beſides various excrements, ſuch as the groſſer fæces of the guts, and the more fluid ones of the bladder, the mouth, the noſe, the pores of the ſkin, *&c.* a great number of corpuſcles, that are not only detained, but aſſimilated by parts of differing ſtructures, as the brain, the heart, the bones, *&c.* ſince otherwiſe theſe parts could never be ſo plentifully nouriſhed by them, as daily to increaſe in all their dimenſions: and it is conſiderable, that ſome parts, which in babes are cartilaginous, do in proceſs of time become bony; which change ſeems not probably referrible to the bare exſiccation produced by native heat increaſing with the perſon's age.

SECONDLY, the friendly corpuſcles of a ſpecific medicine may not only confirm the good eſtate of a determinate part, but, which makes moſt for our preſent purpoſe, they may very much conduce to reſtore it to a ſound condition, when it is diſtempered; and this they may do upon two or three accounts.

FOR, in the firſt place, thoſe friendly particles may diſpoſe the obſtructing or other morbific matter to be more eaſily and ſafely expelled; and this they may do, not barely as they impregnate the whole maſs of blood, and ſo may be carried by it, as well to many other parts, as to that we now conſider; but as by their particular texture, motion, *&c.* they may in a peculiar manner reſpect that peculiar modification, which the peccant matter may have acquired by being produced or harboured in that determinate part. And that the diſtinct ſtructure of an affected part may much diverſify the condition of a morbific matter, I argue from this, among other things, that phyſicians are wont to teach (though I have found the obſervation rather to hold commonly than unreſervedly,) that in thoſe, that are ſubject to the ſtone, the petreſcent matter, when it is bred in the kidneys, is reddiſh or yellowiſh, but when in the bladder, white, or of a light grey; and that the ſtones, that are generated in the firſt named parts, are more friable, or at leaſt of a ſlighter texture, than thoſe, that have their original in the bladder, ſome of which are exceeding hard, eſpecially in compariſon of large ones, that I have had out of the bladder or gall of luſty animals. The aptneſs then, that the corpuſcles of the ſpecific may give the blood, or other liquor, that conveys them, to act as an appropriated menſtruum upon the peculiarly modified matter that obſtructs, or otherwiſe diſaffects the liver, for inſtance, may enable the remedy to be very helpful to that part, by preparing the moleſting matter for expulſion; but it may alſo ſuccour the ſame part in another way.

FOR in the ſecond place, it may ſo work upon the fibres and ſtable portion of the part affected, as both to enable it and excite it to free its ſelf from its enemy; for it may give firmneſs and ſtrength to the fibres of the part; it may alſo contemperate, or correct the immoderate heat, coldneſs, *&c.* of it; it may mortify the acid or other incongruous particles, that are lodged in the minute intervals of the ſtable parts, and perhaps even in the pores of the fibres: it may appeaſe its convulſions, cramps, or other inordinate motions, that hinder it from daily executing its proper functions; it may relax or widen the pores, according to the exigency of the work to be performed: and having thus, by means of its friendly corpuſcles, prepared the matter to be expelled, and diſpoſed the part to expel it, it may then alſo excite the part to do its office, by irritating the fibres, or motive organs, or ſtimulating them to diſburthen the part of the matter, that offends it; as a very ſmall doſe of cantharides is known, by this way of irritation, to be capable of making the bladder forcibly, though not ſafely, diſcharge itſelf of urine, and with that oftentimes expel the ſand and gravel, or leſſer ſtones, and the excrementitious ſlime, that moleſted it before.

AND this inſtance may be of uſe to us in anſwering that, which we formerly noted to be ſo confidently urged by the rejecters of ſpecific medicines: for here we have a medicine, though a dangerous one, whoſe corpuſcles have ſuch a peculiar reference to the bladder and urinary organs, that though, being gotten into the maſs of blood, they are carried by it indiſcriminately to other parts of the body, as well as to theſe; yet oftentimes, without manifeſtly diſaffecting the reſt, they exceedingly irritate the bladder, and determine it to the excretion of what it contains. And whereas it may be objected, that the firſt of the three ways, by which we noted, that a particular part may be ſuccoured by a ſpecific, ſeems contrary to the ſecond; the former tending to corroborate the part, and the latter to relax and irritate it: I anſwer two things, one, that ſince the part may be ſometimes in a natural, and ſometimes in a preternatural ſtate, in the former a medicine may deſerve the name of friendly or appropriated, becauſe it keeps it ſound, which is moſt properly done by ſtrengthening it; and in the latter it may merit the title of a ſpecific, becauſe it helps to reſtore it to a ſtate of ſoundneſs: and the other, that though, to effect this recovery, it is often very expedient, if not neceſſary, that the medicine procure an evacuation of ſome matter, that offends it; yet that evacuation itſelf is often much promoted and facilitated, by ſtrengthening the part ſo, as to enable it to diſburthen itſelf: and the ſame medicine may contain, and communicate to the blood, corpuſcles of ſuch differing ſhapes, ſizes, motions, &c. as may at leaſt ſucceſſively relieve the part by both theſe ways; as phyſicians obſerve, that rhubarb does, not only by its finer and laxative parts, purge the liver of choler, but by its more earthy aſtringent corpuſcles ſtrengthen the tone of that part: [what farther belongs to the illuſtration of this matter will be met with in due place.] On this occaſion it will not be impertinent to add, that, in ſome caſes, this very corroboration of a diſtempered part may reſtore it to ſoundneſs; there being ſome diſeaſes of ſuch a nature, that they are, if I may ſo ſpeak, almoſt always in *fieri*, that is, they could not continue to ſubſiſt in the affected part, unleſs through its debility, and the conſequences of it, it were ſubject to admit from time to time freſh recruits of peccant matter to foment the malady: and in ſuch diſtempers, if the ſtructure and tone of the part be re-eſtabliſhed by the operation of the ſpecific medicine, its acquired vigour will enable it to reſiſt the ingreſs of new ſupplies of peccant matter, and to turn them off into the maſs of blood, to be thence diſcharged by the common ſewers of the body; whilſt, in the mean time, nature will be able by degrees to ſubdue, diſſipate, or otherwiſe diſpoſe of, that comparatively little portion of peccant matter, that was lodged in the diſeaſed part.

WE have not in this paper given any example of the peculiar reſpect of a ſpecific medicine to a determinate diſaffected part, that one would think ſo incredible, as that a heavy ſtony ſubſtance, being in no great quantity taken in at the mouth, ſhould manifeſtly contribute to the cure of a broken bone in one of the limbs, as the leg or the hands; and yet, not to urge the teſtimony of chymical writers, I remember a German phyſician, that was famous for notable cures, related wonders to me of the efficacy of that ſtone growing in his country, which from its effect they call oſteocolla, eſpecially if it be improved by a ſkilful preparation, which he communicated to me, but I had not opportunity to make trial of it. But, without preparation, the judicious and long experienced chirurgeon *Fabricius Hildanus* much commends, upon his own obſervation, a ſingle drachm of it finely powdered, for the breeding of a callus, to ſoder together the parts of a broken bone; inſomuch that he gives a caution to uſe it but ſparingly in young and vigorous patients, leſt it breed too great a callus, of which he gives a notable inſtance: and the like caution was inculcated to me from experience by the lately mentioned German doctor, becauſe otherwiſe, he ſaid, his preparation would in ſuch perſons make the medicine generate a callus too ſoon and too great.

PROPOSITION V.

Sometimes a ſpecific medicine may do its work, by producing in the maſs of blood ſuch a diſpoſition, as may enable nature, by correcting, expelling, or other fit ways, to ſurmount the morbific matter, or other cauſe of the diſeaſe.

HE, that ſhall heedfully obſerve the practiſe of divers learned and ſucceſsful modern phyſicians, may diſcern, that many, if not moſt, of their preſcriptions are founded upon a ſuppoſition, that a great part of the diſeaſes incident to man's body, and the recovery from them, depend mainly upon the vitiated conſtitution of the blood, and the reſtoring it to a ſound condition.

THIS advantageous change of the blood may be effected by a ſpecific ſeveral ways, (ſometimes ſeparately, and ſometimes jointly,) and particularly by thoſe, that follow.

1. THAT, which I ſhall firſt name, is, by furniſhing the blood with ſome ſort of active corpuſcles, that it needs to ferment it, or excite an uſeful commotion or agitation in it.

I WILL not here examine, whether the maſs of blood contained within the veſſels of a living man is capable of a fermentation, properly and ſtrictly ſo called; and therefore I employed alſo the word commotion, which will be eaſily admitted, if the other be diſliked; but in regard fermentation is a term, that hath generally obtained, I ſhall not ſcruple to make uſe of it, after what I have intimated about it.

BUT becauſe many modern phyſicians, eſpecially ſince the learned Dr. *Willis*'s notions came to be in requeſt, have looked upon fevers

vers and agues to conſiſt in, or be produced by various fermentations of the blood; I thought fit to add to the fermentation I am about to ſpeak of, the diſtinguiſhing epithet of uſeful.

THIS premiſed, it ſeems not improbable to me, that as there is oftentimes a vitious fermentation of the blood, ſo there may be ſometimes a want of fermentation, or a certain ſluggiſhneſs, upon whoſe account either the briſk inteſtine agitation, that it ought to have as a warm fluid of ſuch a nature, as it is wont to be in ſound perſons, or a due quickneſs of circulation through the heart, is wanting; to which ſluggiſh ſtate of the blood, if it be obſtinate and laſting, ſeveral diſtempers are wont to be conſequent. Now, although there be divers medicines, ſuch as ſpices, brandy, and other ſpirituous liquors diſtilled from fermented vegetables, that are uſually, and oftentimes ſucceſsfully enough, employed to correct this dull indiſpoſition of the blood; yet in regard they are wont to be very hot, being uſually pitched upon by thoſe, that preſcribe them, becauſe they are ſo, there are ſeveral conſtitutions of patients, and divers other circumſtances, wherein they are not ſafe, but may do more harm by their immoderate heat, than good by their ſpirituoſity; beſides that the ſluggiſhneſs of the blood may ſometimes proceed from cauſes, that this ſort of hot medicines will not correct, I remember, that having, for trial's ſake, moderately dried a parcel of human blood, a vinous ſpirit totally inflammable would not, at leaſt in many hours, that my experiment laſted, make a ſolution of it, or draw a red tincture from it, though it were well pulveriſed; whereas a well rectified urinous ſpirit grew red upon it in leſs than the tenth, or perhaps the twentieth, part of that time.

NOW a ſpecific medicine may abound in corpuſcles of ſuch a nature, that without dangerouſly or incommodiouſly heating the blood, they may diſable thoſe corpuſcles they meet with in the blood, that make that liquor viſcous, or ropy, or diſpirited; and alſo by enlivening the maſs of blood, if I may ſo ſpeak, or putting it into a more briſk and kindly agitation, may make it fit to throw off thoſe heterogeneous parts, or recrements, that were blended with it before, and to permeate, as freely as it ought, the viſcera, whoſe capillary veſſels and pores would formerly ſcarce, and but very ſparingly, admit it.

THAT a ſpecific may perform this, you will perhaps the more eaſily allow, if you conſider, that the generality of phyſicians teach, that there are ſeveral cordials, which they ſtyle ſome of them temperate, and divers of them cold, (as in effect it is not uſually obſerved, that they conſiderably, if at all ſenſibly, heat the body,) as pearls; and ſome of them, being gratefully acid, ſhould rather cool it, as wood-ſorrel (alleluja) and goat's-rue (galega.) And it is very poſſible, that the corpuſcles, that make the blood thick and ſluggiſh, may not be of a cold nature, but of a hot, and therefore may have their effects rather befriended than deſtroyed by divers hot remedies: as, if the white of an egg be, by beating, reduced to water, (which is not neceſſary to the experiment, but ſhews it better) if you put to it a certain proportion of well dephlegmed ſpirit of wine, inſtead of deſtroying the viſcoſity of the liquor, it will curdle a good part of it, and thereby produce a body far more remote from thinneſs and fluidity.

AND I remember I once, for trial ſake, made a vegetable liquor, which, from ſomewhat ſluggiſh that it was before, did preſently, by the addition of a little ſpirit of wine, grow ſurpriſingly viſcous and ropy.

2. ANOTHER way, by which a ſpecific may befriend the maſs of blood, is, by imparting to it a dilatation or tenuity, that it wants. This ſecond way is of much affinity to the firſt, but yet is not the ſame; becauſe in that, the thing mainly conſidered was the fermentation or agitation of the blood; whereas this mainly reſpects the conſiſtence of it, which is a thing of no mean importance to health. For if the blood be too thick, as oftentimes it is, it cannot paſs ſo freely and readily, as it ought, through the capillary veſſels, which thereby come to be by little and little obſtructed, and the circulation inconveniently retarded; whence it is eaſy to foreſee, that divers miſchiefs muſt in time ariſe. And on the other ſide, if the blood be too thin, eſpecially if it be over much agitated too, it is apt to make its way out of the veſſels, and produce hemorrhages, in caſe it flow out of the body, or other bad effects, that uſually attend the extravaſation of the blood; which liquor, when it is out of its proper veſſels in ſo warm a place as a living human body, is very ſubject to putrefaction, and thereby apt to produce impoſthumes and ſeveral miſchievous ſymptoms.

NOW a ſpecific medicine may remedy this faulty conſiſtence of the blood, by furniſhing it with corpuſcles fitted by their figure, bulk, motion, *&c.* to diſable thoſe peccant ones, that make the blood groſs, or elſe to cut, or divide the parts of the blood itſelf, and ſo diſpoſe them to be more fluid; or elſe they may produce in it ſuch pores, as may, as it were, invite the ſubtile æthereal matter, that abounds in the atmoſphere, to inſinuate itſelf into the maſs of blood, and rarify it: and on the other ſide, when the blood is too thin, as not only ſome diſeaſes, but ſome medicines, eſpecially aloes, are wont to make it; a ſpecific remedy may reduce it to a good conſiſtence, either by furniſhing it with corpuſcles apt to combine themſelves with the active ones, that did too much attenuate the blood; or by helping nature to expel thoſe over-buſy particles, by inſenſible tranſpiration, or ſome other undiſturbing way.

3. THERE is yet another way, by which a ſpecific remedy may conduce to rectify the ſtate of the blood; and that is, by ſo working

ing on the heart, as to make it advantageouſly regulate the tranſmiſſion of that liquor through it.

THAT a ſpecific medicine may peculiarly befriend this or that particular part, and conſequently the heart, is granted by the generality of phyſicians, who are wont to reckon up many cordials, (of which yet I fear, but few deſerve that name.) But ſince it is elſewhere in this paper ſhewn, that ſome medicines may particularly reſpect a determinate part of the body, and conſequently the heart; one may be allowed to ſuppoſe, that the corpuſcles of a ſpecific may either diſſolve ſome particles they meet with in the heart, by which that noble viſcus is by irritation, or otherwiſe, diſturbed in the regularity of its dilatations and contractions; or ſo corroborate the fibres, or motive organs of it, as to diſpoſe it to moderate the circulation of the blood, that paſſes through it, in the moſt advantageous way. And that the diſpoſition of the heart, even when men have no ſenſe of it in the part itſelf, may be of moment, as to health and ſickneſs, will appear credible, if we reflect on two things; one, that a living human body is not a meer aggregate of fleſh, bones, *&c.* but an exquiſitely contrived, and very ſenſible engine, whoſe parts are eaſily ſet a work by proper, though very minute, agents, and may, by their action upon one another, perform far greater things, than could be expected from the bare energy of the agents, that firſt put them into motion: the ſecond, (which ſuppoſes the firſt,) that the diſpoſition of the heart being, though perhaps inſenſibly, changed, it may produce a notable alteration in the motions of the blood and its paſſage through the heart, in point of quantity, celerity, or both.

HOW much this change in the circulation may in many caſes conduce to ſickneſs or recovery, may partly appear by the effects of vehement or durable paſſions of the mind; as it is obſerved, that in a deep ſorrow, which does in a manner ſtraiten the paſſages of the heart, the blood being too ſparingly diſpenſed, the enlivening ſpirits are not generated plentifully enough; and (beſides other bad effects of this ſtate of the heart) the blood is ſo diſpirited, as (in theſe parts of *Europe*) to diſpoſe the body to the ſcurvy, which does either produce or irritate divers other maladies. We ſee alſo, that the paſſion of ſhame does oftentimes ſuddenly alter the motion of the blood, and make it ſwell the little veſſels, that lie under the cuticula of the face, and ſometimes other parts; as is very manifeſt in young maids, and other perſons of a delicate complexion, the white part of whoſe faces in bluſhing turns red. The like effect I have ſeen produced by a great and ſudden joy. And though grief, which is the oppoſite paſſion to it, has been uſually taken notice of, as a thing, that deads the appetite to meat; yet ſo much does depend upon a well moderated tranſmiſſion of the blood, that it has been obſerved in divers perſons, and I have known an eminent inſtance of it, that great joy has very much leſſened hunger: of which effect Mr. *Des Cartes* ingeniouſly attempts to derive the cauſe from the varied dilatation and motions of the heart. And it ſeems not abſurd to conceive, that ſuch like motions may be cauſed by the corpuſcles of a ſpecific medicine; which by affecting the fibres of the heart, after the like manner, that joy is wont to do, may produce in it ſuch friendly dilatations and contractions, as are wont to flow from the agreeable paſſions: in favour of which conjecture, I ſhall take notice, that a lady of my acquaintance has complained to me, that the ſmell of perfumed gloves is wont to make the blood fly to her face, and continue there for a great while, giving it ſuch a colour, as if ſhame, or joy had covered it with bluſhes; and the like, ſhe ſays, ſhe has obſerved in others of her ſex. But having in another tract ſpoken of the power of the paſſions of the mind to alter the ſtate of the body, by producing changes in the blood, that is tranſmitted through the heart; what has been ſaid may now ſuffice to make it credible, that a ſpecific remedy, by peculiarly befriending the heart, may contribute much to introduce, or re-eſtabliſh a healthy craſis in the blood; and this being thus rectified, and invigorated itſelf, may both befriend the body in general, and conduce to the removal of ſome particular diſeaſes, by ſtrengthening, and, perhaps too, exciting the particular part, in which the peccant matter reſides, to ſubdue or expel that, which it already harbours, and reſiſt any acceſſion of more. And the blood, being itſelf well conſtituted, as well as the ſtable parts corroborated, the ſpecific medicine, that produces theſe good effects, may be ſaid to cure, though perhaps but ſlowly, divers particular diſeaſes; ſuch as thoſe elſewhere mentioned in this paper, which, to continue, muſt be frequently ſupplied with vitious matter by the circulating blood.

PROPOSITION VI.

Sometimes a ſpecific remedy may unite its particles with thoſe of the peccant matter, and with them conſtitute a neutrum quid, *that may be eaſily proſcribed, or not neceſſary to be expelled.*

THIS I take to be one of the moſt proper and genuine ways of doing good, that belongs to a ſpecific medicine, as ſuch, becauſe in this operation an effect is produced, either without the aſſiſtance, or beyond the meer power, of the manifeſt qualities (as phyſicians call them) of the remedy; and the cure or relief the patient finds is uſually attained without violence, and without tormenting or much diſordering him.

THIS way of working of a ſpecific medicine is of near affinity with one or two of thoſe formerly diſcourſed of; but yet theſe ways differ in ſome things, as may be gathered by the ſequel of § this diſcourſe § ſometimes, when a certain kind of acid has impregnated the blood, or lodged itſelf in ſome ſtable part, as the liver, ſpleen, kidneys, *&c.* the corpuſcles of a ſpecific may, without any ſenſible luctation or conflict, which uſually happens, when acids are mortified by ſapid alcalies, be ſo qualified, as both to make coalitions with the ſmall parts of the peccant acid, and with them to conſtitute little concretions, which, differing from the minute parts of the acid, either in bulk, figure, ſolidity, ſtifneſs, motion, or in two or more of theſe; may be quite of another nature, and of a much innocenter, than the acid was before it was ſo corrected. Of this we may be furniſhed with a notable illuſtration, by what I have elſewhere taken notice of about *aqua fortis* itſelf; for as corroſive a menſtruum as that is, yet by digeſting it, and perhaps diſtilling it too, with an equal, or rather double weight of ardent ſpirit, I found the highly acid liquor would be ſo changed, as not to retain any ſenſible corroſiveneſs, and exchange its piercing ſtink and great acidity, for a not only inoffenſive but pleaſant ſcent, and a grateful and poſitively ſweetiſh taſte; which brings into my mind the practice of a preſident of the famous *London* college, who (as himſelf told me) was wont to relieve a patient of very great quality in nephritic torments, by giving her a good doſe of an inflammable ſpirit. But this upon the by. I have elſewhere given an account of the effects of ſpirit of wine upon ſeveral other acid menſtruums, wherewith I mingled and digeſted it; by which it may appear, that it does not work upon them uniformly, as they are all of them acids, but differingly enough, according to the nature and proportion of the acid corpuſcles, with which the vinous ſpirits are brought to be aſſociated.

AND to ſhew, that this change and contemperation of the menſtruum by the ſpirit of wine is produced rather by a peculiar fitneſs of the convening corpuſcles of both, than by the contrariety or hoſtility, that the vinous ſpirit, which ſome moderns will have to be an alcali, has to the *aqua fortis*, as an acid; I ſhall add, that pure ſpirit of wine being mixed in a due proportion with highly rectified ſpirit of urine, which is reckoned by chymiſts among volatile alcalies, and of which a drop or two is ſo fiery upon the tongue, as to be ready to burn it, or to bliſter it; this vinous ſpirit, I ſay, will very much take off the cauſtic penetrancy of the urinous one, and compoſe with it a ſalt much more moderate, than the ſpirit was, and which being ſublimed, or (which is better, but harder to be done,) reduced into a liquor, affords a mixture of no little uſe in ſome fevers and other diſeaſes, as a medicine; and with a ſmall, if ſkilful, alteration, is of great uſe in divers chymical experiments, as a menſtruum.

A FEW grains of glaſs of antimony, made without addition, being taken inwardly, will vehemently both vomit and purge: but though wine, notwithſtanding its copious ſpirits, will, if it be well impregnated with the corpuſcles of this glaſs, work upwards and downwards violently enough; yet if ſpirit of vinegar, that is, of degenerated wine, be for a competent time digeſted upon this glaſs finely powdered, and, when the liquor is ſufficiently impregnated with the particles of the glaſs, be abſtracted from it, there will emerge from the antimonial and acetous corpuſcles a multitude of minute concretions, of which many grains may be given without ordinarily provoking either vomits or ſtools: which correction may hint, that it is not neceſſary, that all mortifications uſefully made by medicines, ſhould be of acids, ſince here we ſee, that acids themſelves prove correctors: and perhaps it may be by ſome ſuch kind of combinations, that ſome poiſons (for I do not think they all work one way, or peculiarly aſſault the heart) may be ſubdued. And I have ſometimes ſuſpected, that it may as probably be upon this account, as upon any, that has been offered, that a man ſtung with a ſcorpion may be cured, by cruſhing the animal, that ſtung him, upon the hurt; as is preſcribed by many phyſicians, and as an acquaintance of mine told me he tried upon himſelf (as another virtuoſo did on a ſoldier) with good ſucceſs. And when I conſider, what a multitude and variety of figures may fit the corpuſcles, that are endowed with them, to make coalitions very different from both the component parts; I can ſcarce think it very improbable, that in a patient's body there may be made, between the corpuſcles of the peccant matter and thoſe of a medicine, ſuch uſeful combinations, as may produce reſulting concretions, innocent, if not alſo beneficial.

IF I had leiſure, and thought it fit, I could eaſily add a great number of inſtances about ſuch changes of colours, odours, taſtes, and other qualities, as are produced by the coaleſcence of the ſmall parts of differing bodies, and diſcourſe of the natural conſequent of ſuch coalitions; but that having done that ſufficiently in other papers, it will be here more proper to intimate to you, that when a particle of peccant matter comes to be aſſociated with one of a ſpecific medicine, that combination may alter it for the better, not only by changing its bigneſs and figure, but alſo by increaſing, or leſſening its ſtiffneſs and its ſolidity, and giving a new modification to its motion; as a little attention to the natural conſequences of the coalitions of bodies may eaſily induce you to grant.

AND I ſhall add (as it were *ex abundanti*) that the ſmall concretions, made by the union of ſome morbific with ſome medicinal corpuſcles, may not only become innocent, but ſometimes alſo beneficial; which may be illuſtrated by what happens by a further preparation to common ſublimate: for though this be a ſubſtance ſo highly corroſive and miſchievous, that a few grains of it may ſuffice to kill a man; yet by making a coaleſcence of it with leſs than its weight of quickſilver, which is a body inſipid as well as inodorous, the corroſive ſublimate will be ſo altered and tamed, as to be turned into what chymiſts call, becauſe it is freed from ſharpneſs,

neſs, *Mercurius dulcis*; which, if it be ſkilfully prepared and given, though in the quantity of many grains, is not only for the moſt part an innocent thing, but a very good medicine, and that perhaps in more caſes, than phyſicians generally know it to be good in.

The newly mentioned account may hint to us a probable argument to ſhew, that notwithſtanding all the digeſtions and changes that a ſpecific medicine may receive in its way, it may prove a ſalutary one, when it arrives at the part it ſhould relieve. For though the corpuſcles of the medicine ſhould in their way to the part affected be conſiderably changed, yet it is poſſible, that theſe altered corpuſcles may, by that very alteration, be made medicinal; ſince they may be qualified (even by thoſe changes) when they arrive at the part affected, to combine themſelves ſtrictly with ſome corpuſcles, whether morbific or others, that they find already there; and may with them compoſe new concretions, that may acquire a new nature very friendly to the patient. Something analogical to this we may obſerve in aſparagus, which, being eaten, afford ſtore of particles, that, mixing with thoſe they meet with in the kidneys or the bladder, produce a new odour very differing, both from that of meer urine, and from that of the plant itſelf. And ſo if good turpentine be taken at the mouth, it is known, that, arriving at the kidneys and bladder, it will mingle its minute parts with thoſe it meets with there; whence will emerge corpuſcles, that will impregnate the urine with a very differing odour from that, which belongs to either of the liquors, ſince it oftentimes has a fragrancy ſomewhat like the ſmell of violets.

Before I conclude this paper, it is like it will be thought fit, that I ſhould take notice of a difficulty, that I know may be objected, if not againſt the paſt diſcourſe, yet againſt the ſufficiency of it to anſwer the deſign I propoſe to myſelf in writing it. For it may be ſaid, that whereas my arguments and explications ſuppoſe all along, that the ſpecific remedies are taken in at the mouth; it is known, that divers of the aſſertors of ſpecifics reckon among them ſome, that are not by ſwallowing taken into the body, but only outwardly applied, or perhaps do but barely touch it; as may be obſerved in amulets, rings, *&c.* On occaſion of this conſiderable difficulty I have, if I miſremember not, repreſented divers things in another tract: but however, it may be fit in this place briefly to ſay ſomewhat, by way of anſwer to it. We may then take notice, that the confidence, with which many phyſicians reject, and ſome of them deride, external ſpecifics, if I may ſo call them, ſeems to be built upon theſe two things: the one, that the medicine cannot in part, as it is certain it does not in the maſs, get into the body; and the other, that in caſe a ſpecific ſhould have ſome part of it ſubtil enough to gain admittance, that part muſt be too ſmall and inconſiderable to be able to produce in the body any ſuch notable change, as is neceſſary to the expulſion of peccant humours and the conquering of a diſeaſe.

As to the former of theſe grounds, I largely enough ſhew in another paper *, that a man's ſkin, though it ſeems an entire continued body, is really perforated with a great multitude, and perhaps a not inconſiderable variety, of little cutlets and inlets, which we call pores; many of which are viſible, even in the ſkins of dead animals, by good microſcopes, and others are manifeſtly inferred from the numerous little drops, that cover all the ſkin at the firſt eruption of ſweat. And that theſe little perforations may be inlets to the finer particles of externally applied medicines, may appear probable by ſeveral phænomena, ſuch as theſe: that water will ſoak through the pores of a fine bladder, and diſſolve ſalt of tartar, or even white ſugar, contained in it: that I have prepared a certain liquor, whoſe fumes, though not agitated by heat, would quickly penetrate divers membranes of dead animals, and manifeſtly work on metalline bodies wrapt up in them: that it is a known thing, that quickſilver outwardly applied in ointments, girdles, *&c.* will get in at the pores of the ſkin, and invade the internal parts of the body, and ſtay there longer, and perhaps too operate more, than the phyſician deſired. And when once the effluvia of theſe externally applied remedies have gained admittance at the pores of the ſkin, it is not very difficult to conceive, how they may proceed further; for underneath the cuticula or ſcarf ſkin, and cloſe to it, there are ſo great a multitude of capillary veſſels, that you can ſcarce thruſt a ſmall pin into any part, but that the point of it will meet and tear ſome of theſe little veſſels; as will appear by a ſmall drop of blood, that will be made to iſſue out at the new made hole, as ſmall as it is: to which inſtance, if it were neceſſary, I could add divers others of the multitude and ſpreading of the capillary veſſels, that lie cloſe beneath the ſkin, and for the moſt part carry blood, though ſome of them may contain other juices, and diſcharge their recrements by ſweat, or inſenſible tranſpiration, at the cutaneous outlets. Now, theſe capillary veſſels, as ſmall as they are, having their cavities immediately continued with thoſe of leſs ſlender ones, and by their intervention with thoſe of the greater, which are branches of the greateſt of all; the corpuſcles of the medicine once got into the capillary veſſels may have an eaſy paſſage, by means of the liquors they contain, into theſe greater branches of the principal veins, and ſo, by virtue of the circulation, come to be quickly mingled with the maſs of blood, and by it may be eaſily conveyed to all the parts of the body: as it has been oftentimes obſerved, † that arſenical amulets worn upon the breaſt, did, though they ſcarce touched the ſkin, produce threatning diſtempers in the heart, and ſeveral miſchievous ſymptoms in other parts of the body. And I find it recorded in good authors, that cantharides, even when but held in the hand, nay ſometimes though but carried in one's pocket, tranſmitted their hurtful effluvia as far as the bladder, and excited great pain and other bad ſymptoms there.

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* The paper here meant is the eſſay of the poroſity of bodies.

† See this at large proved by the learned *Diemerbroeck de Peſte*, *lib.* 2. *cap.* 11. *in Annot.*

As for the ſecond ground, on which ſpecific remedies are rejected, that though they could get entrance into the body, yet it would be but by their effluvia, and theſe are no way likely to prove efficacious enough to have any conſiderable effect upon an internal diſeaſe; to remove this difficulty, I ſhall briefly obſerve,

1. THAT the number of the corpuſcles, that may paſs from the outward medicine into the body, may be far greater, and therefore make them more conſiderable, than moſt men are apt to think. This may be rendered probable by the great multitudes of odorous, and conſequently ſenſible, expirations, that are continually emitted for a very long time together by ambergreaſe, muſk, civet, and much more by ſkilfully made compoſitions of them. And that alſo ſubtil effluvia, even without the aſſiſtance of heat, may quickly penetrate membranes ſo plentifully, as to act on ſtable bodies contained in them, I have intimated a little above, and have experimentally made appear to divers curious men.

2. THAT the corpuſcles of a medicine may retain their nature, and not loſe their power of operating, notwithſtanding their being, as it were, ſtrained through the ſkin; as may be argued from the mercury, that we not long ſince mentioned to have been found in the form of quickſilver in the bodies of ſome men, that had been too frequently anointed with mercury mixed up with unctuous things into an ointment; by which the patient may be as long and violently ſalivated, as if he had ſwallowed a bolus or pills with mercury.

AND ſo I have divers times obſerved, as I doubt not but others have oftner done, that a little opium, mixed up with other ingredients for plaiſters, did by outward application take off the acute pains of inward parts, though moderately remote from the plaiſter.

3. AND that the corpuſcles of a ſpecific may on divers occaſions act more powerfully, by getting in at the pores of the ſkin, than if the remedy, that afforded them, had been taken in at the mouth; becauſe if it had, the particles might be divided, or perhaps on other accounts, (as by dilution, compoſition with thoſe of the chyle, *&c.*) much altered, by the ferment or the menſtruum of the ſtomach, by their filtration through the guts, and their long and winding paſſage through them and the lymphiducts, before they arrive at the heart to be mingled with the blood: whereas the corpuſcles of the external ſpecific, preſently after they are paſt the ſkin, get into the capillary veſſels of the blood, that lie under it, and by their means are ſpeedily mixed with the circulating maſs of that liquor, and ſo eſcape the formerly mentioned alterations, that other medicines are ſubject to before they are admitted into the maſs of blood. By which it may appear, that thoſe phyſicians are much miſtaken, that think a topical medicine can at beſt relieve but the part it is applied to, becauſe its corpuſcles cannot be ſuppoſed to reach beyond that part of the body, that lies very near the medicine they iſſue from. But though this reaſoning might be excuſable enough, if not allowable, before the circulation of the blood was diſcovered; yet now it is known, how great an intercourſe that liquor maintains between diſtant parts of the body, the argument is not ſeaſonable.

AND on this occaſion I ſhall add an advertiſement, that I remember not I have met with in authors; which is, that bodies outwardly applied may prove ſpecifics for ſome diſeaſes or diſtempers, that one would not think them very good for by the bare knowledge of their effects, when taken in at the mouth. Thus camphire ſwallowed is, in the doſe of a very few grains, a great heater of the blood, and is in ſome countries, perhaps not altogether without reaſon, extolled by phyſicians in ſome kinds of ill conditioned fevers; but outwardly it is applied to take off thoſe redneſſes of the face, that are thought to proceed from heat of blood; and it is uſed in ointments againſt burns. So ſpirit of wine, that is ſo hot when drunk, is a very good remedy to take out the fire, as they ſpeak, in burns, eſpecially if the part be early moiſtened with it. Bread, that is counted ſo moderate and well tempered an aliment, when eaten, if it be chewed and outwardly applied, hath conſiderable virtues in ſeveral external affections. And I know an antient and experienced phyſician, that uſes to purge children, that will not eaſily be brought to ſwallow medicines, by applying ſomething to their navels, that does not offend them by colour, ſmell, or griping; and this himſelf more than once confeſſed to me is but an ordinary aliment, that moſt men, and I among others, have frequently taken unprepared, which he freely named to me, but which I have not yet had opportunity to make trial of.

THAT what we have been ſaying about the poſſible efficacy of external ſpecifics, may appear the leſs improbable, it will be fit to take notice of ſome obſervations, that comport very well with our doctrine. And though the inſtances to be brought will not be all of them of remedies, that deſerve the name of ſpecifics; yet beſides that ſome of them may perhaps have a title to it, they will all conduce to ſhew, that ſimples or drugs, externally applied, may have conſiderable operations againſt internal diſtempers of the body.

IT were eaſy for me to mention a great many external ſpecifics out of phyſicians books; but I purpoſely forbear it, becauſe, to ſpeak freely, I ſuſpect, that moſt of thoſe remedies, though greatly extolled, have been but little examined by the deliverers of them;

and it may ſuffice, for my preſent purpoſe, to alledge a few inſtances, that have been recommended to me, either by my own experience, or that of ſome friends: only there is one obſervation, that is ſo ſolemnly and expreſly delivered by *Galen*, upon his own knowledge, and ſo well-backed by other eminent phyſicians, that I ſhall let it lead the way. This memorable ſtory, that is related by *Galen*, is of a piony root, which having been worn, as an appenſum, about a boy, that had been epileptic for divers months, kept him from his diſeaſe as long as he wore it about him; but when, by an accident, he ceaſed to do ſo, the diſeaſe invaded him again, and yet, by applying the remedy again, he was the ſecond time freed from it; which *Galen* obſerving, did, for curioſity, make the root be laid aſide; but finding the fits to return, he employed it again with the former ſucceſs.

I LIVED in the ſame houſe with a learned and judicious perſon, that was ſubject to be paralytic, who being frequently tortured by violent cramps, was ordinarily and ſpeedily relieved by wearing or handling the tooth of of a true hippopotamus, or river-horſe; and he affirmed to me, that upon leaving off the uſe of it, for any conſiderable time, either out of curioſity, or to accommodate ſome friend, the fits would return with violence upon him. I remember alſo, that having myſelf been for ſome years frequently ſubject to cramps, and complaining of it to a phyſician, that had been a traveller into cold countries, he told me, that he had brought home with him ſome rings made of the true elk's hoof, from a place, where theſe animals are uſually employed, and that with theſe he had cured many of the cramp; and there-withal preſented me one to make trial of, which I the more willingly accepted, becauſe he confeſſed to me, that divers rings, that were ſold for ſuch as his, and looked like them, were either counterfeit, or of no efficacy: and though I did not find, that if the the cramp ſeized me in the calf of the leg, the ring would much relieve me, yet when the fits were but moderate, and in other parts, eſpecially the hands, I found myſelf eaſed ſo often, and ſo ſoon, that I was at firſt ſurprized at it, and uſed to have the remedy laid every night by my bed-ſide, to have it ready, when occaſion ſhould require. And that, which I thought ſomewhat ſtrange, was, that ſeveral times, when the cramp ſeized my foot or my toes, the pain was quickly removed, though I applied the ring but to my finger; which made me much regret the loſs of it.

AN eminent phyſician ſpeaking to me one day of a patient of his, that was ſubject to a nocturnal *incontinentia urinæ*, that was very inconvenient as well as ſhameful; I told him of an empirical remedy, which is mentioned in another paper, whoſe ſucceſs I neither would warrant, nor did altogether deſpair of, and which, at leaſt, ſeemed ſafe, though it ſhould not prove effectual. This was only a ſimple ſubſtance, (belonging to the animal kingdom) that was to be worn in a fine ſarſenet-bag between the ſhift and the ſkin; for which, a good while after, the phyſician gave me great thanks, telling me, that he was ſurprized at the effect of it, and that he obſerved, that when the patient had worn it ſo long, that probably the virtue began to decay, that is, in my ſenſe, the effluvia were almoſt ſpent, the patient found need to take a freſh remedy, to continue the benefit ſhe had found by the former.

I DO not affirm or expect, that the three forenamed appenſa, nor the other remedies I am about to mention, will always ſucceed; and I think, one may aſſign ſome, not improbable reaſons, of the want of uniformity in their effects; but for my preſent argument it ſuffices, that they do ſometimes ſucceed, ſince that is enough to ſhew it poſſible, that outward medicines may operate upon inward diſtempers.

HAVING one day given a viſit to one of the ſkilfulleſt and candideſt phyſicians of the famous college of *London*, I obſerved in his chamber a fine new faſhioned clock; and having taken notice of it to him, as a thing I had not ſeen there before, he deſired me not to think he was rich and vain enough to purchaſe ſo dear a rarity; but that it belonged to a courtier, whom he named to me, of whoſe daughter he told me this ſtory: this young lady had a great tumor in her neck or throat, which being apprehended to be of a ſcrophulous nature, made her father fear it would oblige him to increaſe her portion more than his eſtate could conveniently bear: wherefore at length he addreſſed himſelf to my relator, who judging the caſe to be difficult, and being unwilling to torment the lady with a long courſe of phyſic, told the courtier, that if he could animate her to ſuffer a remedy he would propoſe, and would aſſiſt him to procure it, he hoped to remove this tumour, without weakening her, or putting her to pain. Soon after, all parties being agreed, and the deſired conveniency procured, the patient was brought into a room, where there was yet in bed the body of a man, that had died of a lingering diſeaſe; this man's hand the doctor took, and laid it upon his patient's tumor, keeping it there till ſhe either complained or confeſſed, that ſhe felt the coldneſs of it penetrate to the innermoſt parts of her tumor. This application was afterwards repeated more than once, whilſt the body continued without ſmelling; and by this courſe the tumor was diſpelled, and the patient ſo relieved, that her father, by way of gratitude, knowing how much the phyſician was a lover of curioſities, made him a preſent of that clock.

THE learned doctor aſcribed this odd remedy to *Helmont*, who is indeed to be thanked for having mentioned and recommended a medicine, that was unlikely to be good, beſides that it was not in uſe: but the knowledge of it ſeems to me to have been, for the main, very much ancienter than our age;

ſince there is mention made of one very like it by ſo ancient an author, as *Pliny*; though, ſince his time, till *Helmont*'s, it hath been generally forgotten or diſbelieved, ſave that one phyſician (*Franciſcus Ulmus*) who, though no ill obſerver, has not had the fortune to be famous, takes notice of a caſe very like that of our courtier's daughter, affirming, that by that one remedy, after others had been fruitleſly employed, he knew a noble virgin to have been perfectly cured.

I WAS one ſummer, to my great ſurprize, obnoxious to frequent bleedings at the noſe; for which I ſometimes uſed one remedy, and ſometimes another, for the moſt part with good, but not ſtill with quick ſucceſs: but falling once unexpectedly into a fit, whoſe violence ſomewhat alarmed me, I reſolved to try an unuſual remedy; and having eaſily obtained of my ſiſter, in whoſe houſe this accident happened, ſome true moſs of a dead man's ſcull, which had been ſent her by a great perſon, for a preſent, out of *Ireland*, in which country I found it leſs rare and more eſteemed than elſewhere, I was going to employ it after the uſual manner, which is to put it up into the patient's noſtrils; but before I did it, I had the curioſity to try, notwithſtanding the briſkneſs of my hæmorrhagy, whether the medicine would produce its effect by being only held in my hand; and therefore covering a piece of the moſs with my fiſt, that the warmth might a little actuate the medicine, I found, to the wonder of the by-ſtanders, that the blood ſpeedily ſtopped, nor, thanks be to GOD, have I been troubled with a hæmorrhagy for ſome years from that very time. But this is far leſs ſtrange, than what was affirmed to have happened to one of the eminenteſt members of the Royal Society: this learned gentleman, who was of a very ſanguine complexion, found himſelf much affected by the uſe of the moſs of a human ſcull, [pieces of which I have ſeen ſticking to the roots of the vegetable, when it was genuine] which had ſo ſtrange an operation upon him, that ſometimes, when he was let blood, if, for curioſity's ſake, he held a quantity of this moſs in his hand, the efflux of the blood would ceaſe, till he laid it by again; which was not only ſolemnly averred to me by himſelf, but confirmed to me by his ingenious phyſican, with both whom I had a particular acquaintance, which otherwiſe I ſhould have thought ſcarce credible, unleſs imagination, a faculty very ſtrong in that gentleman, contributed to the ſtrange effect of the remedy.

THE hitherto mentioned external ſpecifics are afforded by vegetables and animals, which, being bodies of a ſlighter texture, may be ſuppoſed to have their parts more effluviable; and therefore I ſhall now add two or three examples afforded by the mineral kingdom, which conſiſting of bodies, that never were living, and which are, for the moſt part, very cloſe and compact, are generally thought to have their parts indiſpoſed to emit effluvia.

I KNEW a perſon of great learning, and, by profeſſion, a phyſician, who enjoyed a health good enough, ſave that uſually, after a few hours ſleep, he waked in the night with great terrors, followed, for a long time, with ſuch violent palpitations of the heart, as were very troubleſome, and ſometimes frightful to him. To remove this diſtemper, he tried all that his art ſuggeſted to him, but without ſucceſs; whereupon he complained of it to ſeveral of his acquaintance, and mentioning it one day among a company of merchants, whereof ſome frequented very remote countries, one of them told him, he would eaſily relieve him by a remedy, that had been found efficacious, both upon himſelf and others. This he told him was, to take divers flat and ſmooth Cornelian ſtones, ſuch as they bring from the *Eaſt Indies*, to cut rings out of; and to ſew eight or ten of them to a piece of ſcarlet or flannel, to be hung about his neck, ſo as that the ſtones may immediately touch the ſkin over-againſt the heart, and the mouth of the ſtomach. This remedy the phyſician procured, and, in no long time, found the great benefit of it, inſomuch that he thought he might now ſecurely leave off the uſe of theſe ſtones, which he did once or twice, out of curioſity, as well as for his eaſe; but finding the diſtemper to return each time, within very few weeks after he had laid aſide his remedy, he reſolved to keep it always on, as he had long ſucceſsfully done, when he told me the ſtory; and, to convince me, preſented me with ſome of the Cornelians, that he had, for fear of wanting them, procured in greater number, than he needed at once. But ſince I have not yet had occaſion to make trial of them, I ſhall not conclude, that the remedy will always ſucceed, but only (which is enough for my preſent purpoſe) that it is at leaſt poſſible, that ſuch an external remedy may be very effectual.

I AFTERWARDS thought (which I here note, to add to the probability of what I have been relating) that poſſibly thoſe, that firſt made uſe of the fore-mentioned remedy, may have had a hint from what *Galen* ſaith of the jaſper; which ſtone we obſerve to be various in point of colour, and I have ſeen in the green mixtures of red almoſt as deep, as that of Cornelians. Of this ſtone *Galen* relates that ſome made rings, in which were graven a dragon, having beams iſſuing from him, and commended it as very friendly to the ſtomach, being applied to the mouth of it: and though he omitted (and found he ſafely might do it) the ſculpture, he yet approves the ſtones upon his own frequent experience, applying them almoſt as our merchant did; *Sane hujus* (ſays he) *ego quoque lapidis abunde feci periculum, torquem enim ex hujuſmodi lapillis confectum collo ſuſpendi, ita ut lapides os ventriculi contingerent*; *apparebant autem nihilominus prodeſſe*; *etiamſi ſculpturam non haberent*, &c. "I have made myſelf a frequent "trial of this ſtone, having carried ſeveral "of thoſe little ſtones tied together about "my neck in ſuch a manner, that the ſtones "did

Galen *de ſimpl. Med. Fac. lib. nono. Tit. de Lapid.*

“did touch the mouth of my ſtomach; yet they were beneficial, though they had nothing graven upon them, &c.”

I HAVE lately mentioned the efficacy of a cramp ring upon ſome parts of the *genus nervoſum*; but ſome will perhaps think it more conſiderable, if a ſtone ring, worn on the finger, ſhall be able to work on the maſs of blood, and particularly that depraved portion of it, that nature relegates to ſuch diſtant parts, as the hemorrhoidal veins: and yet the experienced *Monardes*, having deſcribed the blood-ſtone, that is brought from *New Spain*, and repreſented it as a jaſper, not only commends it againſt hemorrhages, being applied to the bleeding part, but adds the following words, which declare, that he ſpeaks upon experience; *Vidimus nonnullos hæmorrhoidum fluxu afflictos remedium ſenſiſſe, annulos ex hoc lapide confectos in digito continue geſtando: necnon et menſtruum fluxum ſiſti.* “We have ſeen ſometimes the hemorroids cured, as likewiſe the copious monthly iſſues, by wearing rings made of this ſtone.”

Nic. Monard. *Simp. Med. Hiſt. cap.* 36. *p.* 329.

I KNOW you will expect here, that I ſhould not on this occaſion pretermit the *Lapis Nephriticus*; of which ſort of ſtones, though many have been found ineffectual againſt the diſeaſe, that gives them their name, and though it be ſcarce poſſible to chuſe thoſe few, that are good, without having particularly and actually tried them; yet that ſome of them are of great virtue, we have the teſtimony of the inquiſitive and judicious *Boetius*, and that other learned writer about gems, *Johannes de Laet*, whoſe praiſes are confirmed by the hiſtorical teſtimonies of *Monardes* and others. But none, that I have met, ſpeaks more home to our purpoſe than a conſiderable merchant of *Leipſick*, whoſe rare obſervations are recorded by a man of very great reading, the learned * *Untzerus*, to whom I refer you, contenting myſelf to mention, in this place, two of the ten remarks he ſets down; the firſt, that the merchant affirmed to our author, that by wearing this ſtone for ſome days, the calculous matter was ſo powerfully proſcribed, that a multitude of ſmall grains of ſand were expelled, even at the corners of his eyes. The like effect to which he often obſerved of that remedy in divers other perſons. The ſecond, that by wearing the ſame ſtone, his wife, who was troubled with a great catarrh, found it conſiderably cathartic, inſomuch that the firſt day ſhe was thereby purged fourteen or fifteen times, the next nine or ten times, and afterwards had her body kept very open. And he adds, that he found alſo this ſtone to operate like a purge, though not ſo ſtrongly upon himſelf.

Untzer. *de Nephrit. lib.* 1. *cap.* 24.

BUT enough, if not more than enough, of the virtues of periapta and appenſa, eſpecially ſince more inſtances of them may be met with in ſome other papers; and even without them, or at leaſt with them, thoſe particulars, I come from mentioning, may furniſh a ſufficient anſwer to the objection, that has occaſioned them.

The CONCLUSION.

AND now, Sir, you have what the conſideration of the nature of the things I treat of ſuggeſted to me, about the principal ways, by which I conceive ſpecific medicines may cure diſeaſes, or at leaſt much leſſen them. I ſaid the principal ways, becauſe I am far from denying, that there may be many others, that muſt not here be mentioned, leſt I ſhould too much tranſgreſs the limits, that become an epiſtle; eſpecially this being already far more prolix than I at firſt intended; though I purpoſely omitted the authorities and arguments of divers phyſicians and chymiſts, that maintain, that there are ſpecific medicines, becauſe they proceed upon principles, (ſuch as ſubſtantial forms, real qualities, ideas or chaoſes, and the like,) which I could not fairly employ, becauſe I do not admit them. But though I forbore to lengthen my diſcourſe, by improper, and, I hope, needleſs tranſcriptions out of others; yet it is long enough to prompt me now, at the cloſe of it, to remind you of two or three things, that I declared at the beginning.

As firſt, that I did not pretend, that a ſpecific medicine, or nature by a ſpecific, does commonly effect the cure by one of the particular ways, that I propoſed, excluſively to the reſt; ſince I rather think, that oftentimes two, and ſometimes more, concur to the effect. Secondly, that I propoſed to myſelf, to explicate the ways of working of ſpecific remedies, only in general. And thirdly, that I did not aſſert, that the ways I pitched upon were the true and genuine ones, by which the medicine does act, but only propounded them, as ways, by which it may act. So that, without being dogmatical, I offer you my explications, but as poſſible, and perhaps not improbable; and that may ſuffice for the occaſion and ſcope of this letter, in which, I preſume, you remember I aimed but at ſhewing you, that the operations of ſpecific medicines are not irreconcileable to the principles of the corpuſcular philoſophy; which I hope you will, without reluctancy, grant, if, by my good fortune, the difficulties, that made you heſitate, ſeem to you to be leſſened by ſo barren an intellect as mine, diſcourſing of an abſtruſe ſubject, which belongs to a profeſſion, that I am not of. Upon which account it may be juſtly preſumed, that you, who have ſo much more ſagacity, and are ſo much more concerned, than I, in the ſubject I have been treating of; and who, being a profeſſed phyſician, have much more opportunity to diſcover the various courſes, that nature does, or may, take in curing diſeaſes, will be able to give yourſelf far more ſatiſfaction, than you could hope to receive from me, who have therefore propoſed to you my conjectures very diffidently, though I am very poſitive in aſſerting myſelf to be,

SIR, your moſt, &c.

ROBERT BOYLE.

THE
ADVANTAGES
Of the USE of
SIMPLE MEDICINES,
PROPOSED BY
Way of INVITATION to it.

SECT. I.

To the very learned Dr. F.

SIR,

SINCE ſpecific medicines, to deſerve that name, muſt be very efficacious, and yet are, for the moſt part, either ſimple, or very little compounded; what has been ſaid about them in the foregoing tract, concerning ſpecifics, may afford me a not improper riſe to invite you, and thereby others of your profeſſion, on whom your authority and example may juſtly have much influence, to ſeek after and employ, more than they are wont to do, ſuch remedies, as are either ſimple, or, when there happens a neceſſity to compound, are made up of no more ingredients, than are abſolutely requiſite to anſwer the indications, and the phyſician's ſcope.

THIS ſort of ſimple, or but lightly compounded, remedies, I am induced to prefer before thoſe pompous compoſitions, wherein men ſeem to have hoped to ſurmount diſeaſes by the multitude of the ingredients, upon the following reaſons; in all which I deſire the advantages aſcribed to ſimple medicines, above others, may be underſtood, not in an abſolute and indefinite ſenſe, but, as they ſpeak, *cæteris paribus*, which I here give you notice of once for all.

AND the firſt advantage, that I ſhall mention, is, that it is much leſs difficult to foreſee the operation of a ſimple, than of a very compounded medicine; ſo that phyſicians may proceed more ſecurely in employing the former, than the latter ſort of remedies. And indeed, if I do not greatly miſtake, we often preſume too much of our own abilities, when we believe, that we know before-hand, what the qualities and effects of a mixture of many ingredients of differing natures will be; ſince many bodies, by compoſition, and the change of texture, conſequent thereupon, do receive great and unexpected alterations in their qualities. Several manifeſt inſtances of this truth may be met with in our hiſtory of colours; in divers of whoſe experiments, the colour produced upon the mixture of bodies is quite different from that of any of the ingredients; as, when a blue ſolution of copper, made in ſpirit of urine, does with ſyrup of violets, which is alſo blue, produce a fair green: and even ſince I began to write this ſection, a trial purpoſely made has afforded me a new inſtance of the ſame import.

FOR having put together ſome tincture of iron, made with good ſpirit of vinegar, and a volatile tincture of ſulphur, (which I elſewhere ſhew how to make) from a confuſion of theſe two very red liquors there emerged, in a trice, a very dark and almoſt inky mixture, that retained nothing at all of redneſs.

THE like notable changes I have ſeveral times produced by mixtures, in divers other qualities of bodies than their colours, as in their odours, taſts, &c. and why ſuch alterations may not be alſo effected by compoſition in ſome of the medicinal qualities of bodies, I do not yet ſee? Quickſilver itſelf, inwardly taken, does uſually cauſe, either no manifeſt evacuation, or one, that is made at the mouth; but if it be diſſolved in ſpirit of nitre, and precipitated with ſea-ſalt, this white precipitate being edulcorated, if it be warily given in a juſt doſe, doth (as far as I can yet learn) ſeldom work by ſalivation, but by ſiege. On the other ſide glaſs of antimony (made *per ſe*) whereof a very few grains, given in ſubſtance, are wont to work violently upwards and downwards, being diſſolved in ſpirit of vinegar, (which is not eaſily and quickly done) will not uſually either vomit or purge, though the menſtruum be drawn from it, and though it be given in a larger doſe, than that of the uncompounded glaſs.

And though if crude antimony be fluxed with nitre and tartar, as in the ordinary way of making crocus metallorum, there is produced, as is vulgarly known, a medicine ſo emetic and cathartic, that an ounce or leſs of the wine, wherein it has been infuſed, without ſenſibly loſing its weight is wont to work ſtrongly enough both upwards and downwards; yet I have known ſome, that would without ſcruple take ſeveral grains of crude antimony in ſubſtance, and one particularly, that continued the uſe of it long, without being vomited or purged by it. And trials purpoſely made have informed me, that if, inſtead of ſalt-petre and tartar, antimony be prepared with well dried ſea ſalt and a little ſalt of tartar, though both theſe amount not to above half the weight of the nitre and tartar vulgarly uſed; yet the antimony well fluxed with theſe (for about an hour) is thereby ſo altered and corrected, that it affords an uſeful medicine, of which one may give from 12 or 15 grains to half a drachm, or more, in ſubſtance, without ordinarily working, either by vomit or ſiege, but uſually by ſweat, and ſometimes by urine: whence we may gather, that antimony may be either made a more dangerous, or a more friendly medicine, than of itſelf it is, according to the ingredients it is aſſociated with, though theſe be in themſelves innocent, and perhaps of kin to one another. And even chymiſts, as well as other preſcribers of remedies, may be found, though leſs frequently, to add to a ſimple ſuch things, as rather deprave, than improve it: as one of their great patrons (a happy practitioner) complains, that flower of ſulphur, by being ſublimed, (as by many it is) from calcined vitriol, and one or two other things, under pretence of purifying and ſubtilizing it, does really acquire a hurtful corroſiveneſs. And, if I had here the leiſure, inſtances enough might be brought to ſhew, that chymiſts ſometimes miſtakingly produce, by their additions to a medicine, other qualities, if not alſo worſe, than they deſigned or expected.

SECT. II.

ANOTHER advantage of ſimpler medicines is, that *cæteris paribus* they are more ſafe than compounded ones, eſpecially if the patients be valetudinary perſons. It is too much the cuſtom, both of many Herbariſts, and ſeveral other writers on the *Materia Medica*, to give us rather encomiums, than impartial accounts of the ſimples they treat of; enumerating and magnifying all the virtues they have, and ſometimes more than they have, without taking notice of their ill qualities, upon whoſe account nevertheleſs they may be inconvenient, if not hurtful and dangerous, to ſome conſtitutions, and in divers caſes. We know, that divers perfumes, as muſk and amber, though very grateful and refreſhing to moſt men's ſpirits, are yet very hurtful to many women, and eſpecially to thoſe, that are hyſterical. And I have known the ſmell of muſk very much diſaffect an eminent perſon, though otherwiſe of a robuſt conſtitution. I have alſo known ſeveral perſons, not all of them of the ſame ſex, very much offended by the ſmell of roſes, which yet is very moderate, as well as to moſt perſons, whether men or women, very grateful. I know a very great perſon, to whom honey, whether inwardly taken, or outwardly applied, is almoſt as hurtful as poiſon, having ſeveral times produced ſtrange and frightful ſymptoms, even when the patient knew not, that any honey had been employed, and conſequently could not be thus oddly diſtempered by the force of imagination. I think I have elſewhere taken notice of the harm, that both I and others, ſubject to diſeaſes of the eyes, have received, even by the moderate uſe of parſley.

ON this occaſion I ſhall add what occurred to me long after I had dictated what I ſaid of parſley, that wormwood, though for many uſes an excellent plant, has been found by many ſo apt to diſaffect the head, and ſo unfriendly to the eyes, that I have for ſome years forborn it myſelf for fear of the head-ach, and forewarned others of it, that are ſubject to weak eyes. But I know a very learned man, whoſe elegant pen has made him deſervedly be taken notice of by many, who though he have naturally very good eyes, found upon an obſtinate trial, that his curioſity ſeduced him to make, of the plentiful uſe of wormwood-wine and beer, that within leſs than three weeks his ſight was by degrees brought to be ſo weak, that he could not read a *Gazette* without ſpectacles; but by totally leaving off wormwood, he quickly recovered the vigour of his ſight, without the uſe of any of the helps, that his profeſſion, which is phyſic, would have plentifully ſuggeſted to him. This relation I had from himſelf, ſoon after the thing happened, on occaſion of what I told him about parſley, *&c.*

AND to ſpeak more generally, I doubt not, but if men were not ſo prepoſſeſſed with the praiſes, that authors give to ſimples, that they overlook the inconveniencies they may on divers occaſions produce, we ſhould find in many medicines bad qualities, that are not yet taken notice of. And I have more than once hit but too well in the prognoſtics I made of the hurt ſome patients would receive by the uſe of applauded medicines, preſcribed them even by conſiderable and learned men, when upon their authority my warnings were neglected, and the uſe of the medicines unhappily perſiſted in. I remember I once ſaw, in the hands of a learned and curious traveller into the eaſtern parts of the world, an Arabic manuſcript about the *Materia Medica*, which made me regret the loſs of the moſt part of the little ſkill I once had in that language; for beſides that it was written in a delicate hand, and the letters in fit places, curiouſly adorned with gold and azure, the method ſeemed to be more accurate, than any thing I had ſeen on that ſubject: and that, which pleaſed me not a little, was, that the author had been ſo wary, that after the columns, wherein he taught, beſides many other things, the virtues, doſes, *&c.* of every drug he treated of, he had a diſtinct column for the bad qualities of it, and the conſtitutions and diſeaſes, wherein the uſe of it may be dangerous or inconvenient. I think it therefore not unreaſonable to ſuſpect, that, where a great many ingredients are blended into one medicine, one or other of them may have other operations, beſides that deſigned by the phyſician: it may awaken ſome ſleeping ferment, and, if not produce a new diſtemper, may excite and actuate ſome other hoſtile matter, that lay quiet in the body before, and perhaps would have been little by little ſubdued by nature, if it had not been unſeaſonably rouſed and aſſiſted by ſome ingredient, that perhaps was needleſſly put into the medicine. I have had ſo many unwelcome proofs of this in myſelf, that it engages me to be the more careful to caution others againſt the like inconvenience.

SECT. III.

ANOTHER benefit accruing from the uſe of ſimpler medicines is, that thereby the patient may, without burthening his ſtomach, or nauſeating the remedy, take a larger doſe of the medicine, or of that ingredient of it, wherein the virtue chiefly reſides. For, whereas phyſicians are obliged to ſtint themſelves in the doſe of the medicine, for fear of diſguſting the patient, or oppreſſing his ſtomach; when there are many things heaped together in a moderate doſe of one compounded medicine, theſe ingredients that are either ſuperfluous, or at leaſt are leſs efficacious, muſt neceſſarily take up a conſiderable part of that determinate doſe, and conſequently leave much the leſs of the more appropriated or uſeful ingredients.

To ſay, that all the ingredients, that are thruſt into a great compoſition, are proper and conduce unto the ſame purpoſe, I doubt is not always true; and however is not a ſufficient anſwer, ſince it does not avoid the inconvenience I have been objecting.

If a baker, being to make the beſt bread he can, eſpecially for a perſon of a weak ſtomach, ſhould to wheaten flower add the meal of rye, of barley, and of oats; though all theſe ingredients be good and nouriſhing, and each of them is by many uſed to make bread, yet none will take him for a ſkilful baker, and few would prefer this compounded bread, to that more ſimple one made of wheat alone. And ſo to make good gunpowder, a ſkilful man would not to ſaltpetre, brimſtone, and charcoal, add wax, roſin, and camphire, though theſe be very inflammable ſubſtances as well as ſulphur. And thus if one would make an *aqua vitæ*, whereof but one ſmall cup were to be given for the quick recovery of fainting perſons, he would not with ſpirit of wine, or good brandy, mix mead or cyder, and ſtrong beer or ale, though each of theſe be itſelf a ſpirituous liquor.

Gum Arabic (whereof I prefer that, which is tranſparent and colourleſs) is preſcribed in ſeveral compoſitions, as a drug proper to mitigate the ſharpneſs of urine; but by the quantity of the other ingredients, that it is mixed and clogged with, no more than a ſmall proportion of it uſually comes to be given in one doſe; but when I have had the curioſity, leaving out all the other things, to give about a drachm, or perhaps more of it at one time, reduced by long pounding (for the beſt is very tough) to fine powder, in a large draught of beer, or ſome other convenient vehicle, I found very conſiderable effects of it. And I remember, that a gentleman of great note coming to bid me farewel, becauſe of a long and troubleſome journey he was taking to mineral waters, which he intended to drink for many weeks, to eaſe him of a very painful ſharpneſs of urine; I, that knew it was not venereal, nor from the ſtone of the bladder (for when thoſe are cauſes of the ſtrangury, the medicine is not near ſo powerful) deſired him, before he went, to make uſe of this powder, once, or (if there ſhould be need) twice a day; which when he had done, it ſo relieved him, that he thought himſelf quite cured, and forbore his intended journey not only that year, but the next. For the chin-cough, as they call it in children, whoſe odd ſymptoms do uſually fright the parents and attendants, and oftentimes fruſtrate the endeavours of phyſicians ſkilful in curing other coughs, I have not known any magiſterial compoſition ſo effectual, as the ſimple juice of pulegium (by many called penny-royal) ſweetned a little with ſugar-candy, and given long enough from time to time, in the quantity of a child's ſpoonful. (This plant may be alſo made to afford a ſyrup, that will keep, and is uſeful in coughs, but which I doubt, is not ſo efficacious as the ſimple juice.) There are many and obvious experiments of the great efficacy of ſo ſimple a remedy as aſſes milk, (which yet, in ſome caſes, I think inferior to goat's milk,) if it be given in a ſufficient quantity, and for a competent time. There are alſo many inſtances of dangerous and ſtubborn diſeaſes, that have been cured even by common cow's milk, when it has been very plentifully taken, and for a long continuance of time: and perhaps it is no leſs remarkable, that in a far leſs time, now and then, not extending to very many days, fluxes, as diarrhæas, and, though more ſeldom, even dyſenterical ones, are happily and eaſily cured, as I have ſometimes known, by the bare uſe of ſo ſlight a remedy as milk, wherein, whilſt it is gently boiling, an equal quantity of fair water is little by little put, till at laſt there remains but as much liquor, as the milk alone amounted to at firſt. This ſimple alimentous medicine being liberally taken (for it ſhould be uſed inſtead of all other drinks, whilſt the diſeaſe continues) has been very frequently found to cure fluxes, not all of one ſort, in *Ireland* itſelf, where that kind of diſeaſe is endemical. And, though I have formerly in another paper recommended the uſe of *Paronychia foliis rutaceis*, againſt that ſad and ſtubborn diſeaſe, the king's-evil; yet I preſume you will allow me, by the mention of a trial, that was ſince made with it, to give a notable confirmation of the utility of giving an alterative ſimple, if need require, in conſiderable quantity. A phyſician, that I knew, was ſent for to a ſcrophulous patient, in whoſe throat there was a tumor, ſo big and ſo unluckily ſeated, that, much compreſſing the œſophagus, it rendered deglutition exceeding difficult; ſo that being likewiſe ſo hard and ſtubborn, that though the phyſician was alſo a famous chirurgeon, he could neither diſcuſs it, nor bring it to ſuppuration; the patient, though rich, was in imminent danger of being ſtarved. In this ſtrait the phyſician remembring the character I had given of paronychia, or whitlow graſs, ſent about the country to get all that could be procured; and at firſt gave a little of it, in form of infuſion, in ſuch liquid aliments, as the patient was able, with much ado, little by little to get down: and having by this means, after ſome time, made the deglutition leſs difficult, he gave the remedy more and more plentifully, to imbue the whole maſs of blood and juices of the body with the virtue of the herb; whereby the tumor was at length reſolved, and the patient ſecured, ſo much to the phyſician's reputation as well as profit, that, as he ſaid, he thought gratitude obliged him to give me a circumſtantial account of his ſucceſs; as he very civilly did in a long letter, whereof I have given you the ſubſtance.

AND though I might here entertain you with the virtues of ſome other ſimple remedies plentifully given, yet for brevity ſake I ſhall rather obſerve in general, that I doubt not but ſeveral ſimple medicines (I ſpeak of alterative, not evacuating ones) would be found far more effectual, than they are commonly thought, if they were given in a much larger doſe, and continued for a competent time. And probably ſo many phyſicians (eſpecially of the old ſchool,) would not be ſo forward to reject either ſpecific or ſimple remedies, as having found ſome of them not to anſwer expectation, if they would allow them as fair a trial, as they give to their own preſcriptions; ſuch as the chalybeats of the ſhops, the Spaw, or Tunbridge waters, the decoctions of guajacum, *&c.* which they often give with divers intermediate helps for a month or ſix weeks, and ſometimes for two months together, without expecting, that in a few weeks, much leſs in a very few days, they ſhould perform the cure.

SECT. IV.

THE fourth thing, that may recommend the uſe of ſimple medicines, is, that *cæteris paribus* they are more eaſy to be procured, than compounded ones. This aſſertion needs little proof. And where ſeveral ſimples are required, one or more of them may oftentimes be difficult to be got; and all of them will ſtill be troubleſome to be fetcht, and to be made up into a compoſition. How uſeful the knowledge of parable remedies may be, I have endeavoured to ſhew in a diſtinct paper; and therefore ſhall not diſcourſe of it here, but only add this one obſervation, that ſome medicines are ſo parable, that without reſorting for them to apothecaries ſhops (which are not every where at hand, nor always furniſhed with them) we may find them in thoſe of other tradeſmen. Thus among maſons and bricklayers we moſt commonly meet with quicklime; whoſe bare infuſion in common water [about a pound of the former, as it is more or leſs ſtrong, to about three or four quarts of the latter,] is of itſelf a good medicine in divers caſes, and, as experience has perſuaded me, may be made the baſis of ſeveral good remedies, both inward and outward; among the latter of which may be reckoned an ointment, that I uſually kept by me for burns, and made only by beating up ſtrong lime-water with as much good linſeed oil, as could be made throughly to incorporate with it into a very white unguent.

And I ſhall add concerning linſeed oil, (ſince I have mention'd it) which is to be had in the ſhops of varniſhers and painters; that of itſelf, being exhibited in a large doſe, as of ſeveral ounces at a time, I have known it anſwer the commendations given it by eminent phyſicians, for breaking of pleuritical empyemas. Simple oil of turpentine alſo, that may be uſually had in the ſhops of the ſame tradeſmen, is in reality a noble remedy in divers affections, not only inward, in which chymiſts commend it, but outward too. And I have had great thanks, both from phyſicians and chyrurgeons, for recommending the uſe of it to them in wounds, and particularly, where one would expect little from it, in the ſtanching of blood, if it be ſeaſonably applied very hot to the wounded parts, where it alſo much promotes a good digeſtion. And I am confirmed in the good opinion I have long had of this oil, by the information, that is given me, that a very experienced chirurgeon has lately been ſo charitable, as to publiſh a little book, conſiderable for the uſeful obſervations it contains, of notable cures done by him in chirurgical caſes, chiefly with oil of turpentine. And I ſhall add, that a chirurgeon to a great monarch, and one of the ſkillfuleſt men I ever met with of his profeſſion, confeſſed to me, that in an admired cure, that he had then lately done of a deſperate gangrene in an eminent perſon, very aged and almoſt bed-rid, the medicine he aſcribed moſt to, was the oil we were ſpeaking of. And, becauſe both he and others make much and good uſe of ſpirit of wine in gangrenes, which yet is thought to be unmingleable with oil of turpentine, becauſe if it be ſhaken with it, it will quickly ſeparate again from it; I thought it might do practitioners ſome ſervice, to make for them a mixture

ture of oil of turpentine and ſpirit of wine, that might probably be more penetrant than the former, and leſs fugitive than the latter, which of itſelf does not ſtay long enough upon the parts it is applied to: which mixture I eaſily made, by digeſting for a while, and ſtrongly ſhaking from time to time, about equal parts by gueſs of good oil of turpentine and throughly dephlegmed ſpirit of wine, till this liquor, by imbibing or diſſolving great ſtore of the oleaginous parts, have attained a yellow colour, for which reaſon I call it the tincture of oil of turpentine.

And ſince my ſubject has led me into the ſhops of colour-ſellers, I will, before I leave them, take notice of one ſimple, that is wont to be found there, which if it were not very offenſive to the taſte, and ſomewhat diſagreeable to the ſtomach, would be perhaps preferable for its antinephritick virtue to the moſt pompous compoſitions of the ſhops, and ſome of the celebrated arcana of the (vulgar) chymiſts. I procured it, not without ſome difficulty, from a ſpagyriſt very well verſed in the ſchool of *Paracelſus* and *Helmont*, who, though a ſparing commender of remedies, extolled this, as the beſt he had ever met with, to cure the ſtone, where it was too big to paſs, and to prevent the increaſe of it where it was. I have known it uſed in clyſters, with very good ſucceſs in a fit of that diſeaſe; but inwardly I had no occaſion to try it but upon myſelf; and judging it innocent enough (as indeed I found it rather anodyne than driving) I took it now and then, mixed with oil of ſweet almonds chiefly to allay the taſte, (for otherwiſe I had long found that alone inſufficient) as a preſervative from gravel. And thanks be to God, I divers times thought it more manifeſtly effectual to that purpoſe, by leſſening either the bulk of the grains, or the quantity of the ſand, or both, than any of the remedies I had taken for ſeveral years before: and yet I ſcarce took a quarter of the doſe preſcribed by the ſpagyriſt, that communicated the medicine to me; which in ſhort is (for I preſume you would gladly know it) to take from time to time, by itſelf or in ſome convenient vehicle, two or three ounces of the expreſſed oil of walnuts, which, if the great ſtaleneſs of it he requires be neceſſary, (which I mean to examine by trials) is ſcarce to be had but at the ſhops of artificers, becauſe he would have it at leaſt a year old, and judged it the elder the better.

Before I quite leave the ſhops of tradeſmen, I ſhall take notice of one medicine more, that ſeems to have been firſt lodged there, and from thence tranſlated into the ſhops of apothecaries. The medicine I mean is Caſtile or elſe Venetian ſoap, (for either is often employed inſtead of the other) which being a body abounding with alcaliſate ſalts and oleaginous parts well combined, invited me to make ſome experiments with it, as a ſubſtance, that may be applicable to good uſes, not only mechanical but medical. Of ſome of the former ſort I elſewhere make mention; and as to its medicinal virtues, I take notice in another paper of its efficacy againſt the jaundice; for which I have ſince been informed, that, as nauſeous a medicine as it is, it is in great requeſt among ſome ſkilful men in *Holland*; and ſome freſh, but not ſufficient, experience has recommended it to me againſt the ſtone. But that virtue of it, which I as yet moſt prize it for, and now intend to communicate to you, you will beſt gather from the following ſtory. Having had ſome dealings with a conſiderable merchant of *Cork* in *Ireland*, he ſadly complained to me, that he was afflicted with a neceſſity of making bloody water to that degree, that he feared he muſt ſoon quit his profeſſion, being already unable to ride about his buſineſs, and ſcarce able to walk a foot the length of a ſtreet, without ſtooping to make red water. Hereupon I told him I had a medicine, that, if he could digeſt the unpleaſantneſs of it, would, I thought, by the bleſſing of God, do good even in his caſe; and it was only to ſcrape with a knife as much Caſtile ſoap into a ſpoon, as it would conveniently hold without being preſſed, *i. e.* near a dram; and having filled the vacant part with ſmall ale, or ſome other convenient drink, to facilitate the ſwallowing ſo nauſeous a remedy, waſh it down with a ſomewhat large draught of the ſame liquor, or other fit vehicle, repeating the doſe twice or thrice a day, if need required. The manifeſt relief he found by this ſeemingly deſpicable medicine, within (if I miſremember not) two or three days, invited him to continue the uſe of it a while longer, and afterwards to return me ſolemn thanks for it; declaring, that now for four years together he had lived quite free from his diſtemper, without ſcrupling to ride journeys on horſe back, as his occaſions required. To which he added, that in regard I had not confined him to ſecreſy, he preſumed I intended the medicine ſhould do as much good as might be, and therefore ſcrupled not to give it to ſeveral others, who were likewiſe happily cured by the uſe of the ſame remedy. Which account was therefore the more welcome to me, becauſe in the place, where I lived, I had not opportunity to make further trials of its efficacy. And on this occaſion I ſhall beg leave to advertiſe you once for all, in reference to the remedies delivered by me, either in this paper or in my other writings; that I am as ſenſible as another of the almoſt inſuperable difficulty of making any certain experiments in phyſick; and that having of a long time (for reaſons given in due place) ſtudiouſly, though not unreſervedly, declined the occaſions of giving (and conſequently of reiterating) medicines; I juſtly deſire, that none of my readers, and eſpecially that Dr. F. would too much rely upon them, till they have been more competently tried, than perhaps ſome of them, for want of opportunity, have been; and adminiſtred to patients of differing complexions, ages, and other circumſtances.

You may find other inſtances of the virtue of parable, and ſome of them unpromiſing medicines, in one of my eſſays *of the uſefulneſs of experimental philoſophy*; to which I the leſs ſcruple to refer you, becauſe I do not remember what I have there written many years ago ſo perfectly, as not to fear, that I might, by enlarging this ſection, put you to the trouble of reading ſome things here, that you have met with there already. And yet I am ſomewhat encouraged both to mention to you that book, and to preſent you ſome other receipts in this paper, becauſe it has pleaſed God ſo far to bleſs divers of the medicines I have there recommended, or do there mention, that they have been proſperous to many patients, and not altogether unuſeful to ſome noted phyſicians; and have procured me from both more thanks, than I pretended to, beſides inviting encouragements to further communications.

SECT. V.

THE laſt thing in order, but not in importance, that induces me to wiſh, that phyſicians would employ ſimpler medicines as much as conveniently may be, is, that it is one of the likelieſt ways, (and perhaps little leſs than abſolutely neceſſary) to promote the practical knowledge of the *materia medica*. For, whilſt in one receipt a multitude of ingredients are mingled, if not confounded, it is almoſt impoſſible to know with any certainty, to which of the ſimples the good or bad effect of the remedy is to be attributed, or whether it be not produced by a power reſulting from the particular qualities of all of them, united into one temperament, and by its means acting conjointly, and, as the ſchoolmen ſpeak, *per modum unius*. So that by this way of heaping up or blending ſimples into one compounded remedy, I ſee not, how in many ages men will be able to diſcover the true qualities good and bad of the particular bodies, that are compriſed under the name of the *materia medica*; whereas, when a phyſician often employs a ſimple, and obſerves the effect of it, the relief or prejudice of the patient may very probably, if not with medical certainty, be aſcribed to the good or bad qualities of that particular remedy.

And this difficulty of diſcerning, what ingredient it is of a very compounded medicine, that helps or hurts the patient, is much increaſed to thoſe, who affect to write bills, wherein ſomething is preſcribed, which, though, becauſe it goes under one name, it paſſes but for one ingredient, is yet a very compounded body; as is evident in thoſe many pompous receipts, wherein are treacle, (that alone conſiſts of above ſixty ſeveral ſimples) mithridate, and divers other famous ancient compoſitions, that each of them conſiſts of good ſtore of ingredients. I had once thoughts of drawing up a diſcourſe of the difficulties of the medicinal art, and had divers materials by me for ſuch a work, which afterwards I laid aſide, for fear it ſhould be miſemployed to the prejudice of worthy phyſicians. But among the difficulties, that occurred to me, I ſhall on this occaſion mention one; which was, that it is a harder work, than moſt men think, to diſcover fully the nature, or the good and bad qualities, in reference to phyſick, of this or that ſingle plant, or other ſimple, that has a place in the *materia medica*; for beſides the great difference, that there may be in plants of the ſame denomination, according to the climate, ſoil, the goodneſs of the ſeeds, that produce it, the culture, or the want of it, the time of the year, the ſeaſonableneſs or intemperateneſs of the weather, the time and manner of gathering it, how it has been kept, the parts of it, that are, and thoſe, that are not made uſe of, together with other circumſtances too many to be here enumerated; beſides all theſe, I ſay, the unheeded textures of parts, that are thought of an uniform nature, and the length of time, during which they have been kept, without being ſuſpected to be ſuperannuated, and indeed without being ſo, may ſo much vary the nature of a plant, that I have ſometimes, almoſt in a trice, ſhewn the curious a notable diſparity in the parts of the ſame freſh leaf of a common plant: and (NB.) I have found by trial purpoſely made, that ſome ſeeds of common uſe in phyſick (and not putrefied) will, being diſtilled at one time of the year, afford an acid ſpirit or liquor; but at another time of the year, though diſtilled the ſame way without any addition, afford not an acid, but a kind of urinous ſpirit, that contains a volatile ſalt, which in ſmell, taſte, and divers operations, I found to be of great affinity to to the volatile ſalt of urine, or that of hartſhorn. And indeed ſo many things may be pertinently and uſefully propoſed to be inquired into, about this or that particular plant made uſe of by phyſicians, that perhaps they would be leſs inclined to compound numbers of them in one receipt, if they were aware, how much uſeful employment the indagation of the qualities of ſo much as a few ſingle plants would give them: and yet without the knowledge of the properties of the ſeparated ingredients a phyſician preſcribes, it will be ſcarce poſſible for him to know, with ſufficient certainty, how the compound made up of them will be qualified and operate; which reflection I the leſs ſcruple to propoſe, becauſe I am confirmed in it by *Galen* himſelf, which very book, where he largely treats *de medicamentorum compoſitione*, hath this aſſertion; *in univerſum, nemo probe uti poſſit medicamento compoſito, qui ſimplicium vires prius non accurate didicerit.*

Galen. de Comp. Sec. Gen. lib. 1.

I preſume you will eaſily allow, that much of what has been ſaid in favour of thoſe ſimple medicines. we owe to nature's (or rather to its author's) bounty, may be extended to many of the remedies, that are afforded us by the chymiſt's art. For without now entering into the queſtion, whether the ſpirits, oils, and ſalts, that are obtained by what ſpagyriſts call analyſes by the fire, are principles in the ſtrict ſenſe of the word; it will ſcarce be doubted, but that the ſpirit, or the oil, or the ſalt of a mixed body chymically reſolved, is ſo ſlightly or unequally compoſed, that the ingredient, whence it takes its name, is far more predominant, than it was, when combined with others in the entire or not yet analyſed concrete. And that ſuch ſuppoſed principles, or medicines of a ſimpler order, may be very efficacious remedies, may be juſtly argued from the great and beneficial effects of ſuch as oil of vitriol, ſpirit of urine, (NB.) a medicine of great uſe both inward and outward, ſpirit of hartſhorn, ſpirit of nitre, ſpirit of wine, and oil of turpentine: of which laſt named liquor I ſhall add, that, beſides the virtues already aſcribed to it in this paper, whilſt it retains its ſimplicity, it may in many caſes be employed as a menſtruum, and, by being combined with an ingredient or two, be made to afford divers medicines, which though but little compounded, are not of little virtue; for I have found it readily enough to diſſolve camphire, maſtick, and ſome other gums, of which balſams may be made, and others may be obtained, by the help of the ſame liquor, even from divers mineral and metalline bodies. I will not inſiſt on ſo known a medicine, as the common terebinthinate balſam of ſulphur; though this be a remedy, which as much as it is peculiarly extolled for diſeaſes of the lungs, (wherein yet its heat requires, that it be very warily given to patients of ſome complexions) has virtues, that are not confined to the diſtempers of thoſe parts; ſince both I, and ſome I commended it to, have found it very effectual (outwardly applied) in troubleſome hæmorroidal pains and tumors: and (NB.) ſome experience inclines me to think its virtues may not be much greater in pulmonick, than in paralytick diſtempers; in which (laſt) it may be uſed not only outwardly, but chiefly inwardly; and that in a pretty large doſe with a cephalick, and, in ſome caſes, an antiſcorbutick vehicle. But I ſhall rather take notice to you, that perhaps it will be found worth while to try, at leaſt in external affects, the uſe of divers tinctures, and conſequently balſams, that may be obtained by the help of oil of turpentine from divers ſolid mineral bodies, upon which I have found by trial, that this liquor may be tinged (though not of the ſame colour on all of them ;) among which I ſhall name, beſides crude zink, crude antimony, and even crude copper (in filings;) a noble ſubject, antimonial cinnabar, from which, though I found I could (but not haſtily) draw a fine tincture, I had not opportunity to make trial of that promiſing medicine.

SECT. VI.

AND as for thoſe other medicines, that are not made by bare analyſis, but by ſyntheſis or compoſition; though I think an experienced chymiſt may, in many caſes, with leſs uncertainty than a Galeniſt (who employs crude ingredients of a more compounded nature) foreſee what quality the produced mixed body may have; yet I could wiſh, that even the Spagyriſts themſelves were more ſparing, than many of them are, in the number of the ingredients they employ to compoſe one medicine: for moſt of the arguments, upon which I grounded my invitation to the uſe of ſimple remedies, are applicable to chymical ones, as well as others; and on this occaſion I ſhall repreſent two things.

FIRST, that, in many caſes, preparations ſkilfully diverſified may be uſefully ſubſtituted to compoſition; ſince one body, dexterouſly expoſed to differing operations, may acquire as various, or as conſiderable, qualities, as would accrue to it by the addition of ſuch other bodies, as an ordinary chymiſt would in probability aſſociate with it. Thus, not to mention quickſilver, antimony alone, whether prepared without addition, as when flowers of ſeveral ſorts are made of the more volatile, and true antimonial glaſs of the more fixed part, or being aſſociated but with one or two ingredients, may afford a ſkilful Spagyriſt medicines numerous and various enough, almoſt to furniſh a ſhop; or at leaſt to anſwer the phyſician's ſcope, where he would employ an emetic, a cathartic, a diaphoretic, a deobſtruent, a diuretic, a bezoardic, or cordial medicine; to name now no other qualities, that may be found in ſome antimonial preparations in a degree conſiderable enough to ennoble them: which inſtances, and others of the like nature, I preſume you will allow me to make uſe of in this diſcourſe, becauſe, though I do commonly, yet I do not always, employ the term ſimple medicine or remedy in the ſtrict and abſolute ſenſe, but in a comparative one, that excludes compoſitions of more than two or three, or at the utmoſt a very few, ingredients.

SECONDLY, without bringing together a chaos, or ſo much as a conſiderable number, of ingredients, one or two, or at moſt three auxiliary ones, if judiciouſly choſen and ſkilfully managed, may oftentimes produce more efficacious remedies, than the admirers of pompous proceſſes would expect, or perhaps be able to make thoſe proceſſes vie with. The violently emetic and purgative virtue of glaſs of antimony made *per ſe* may be, as I elſewhere ſhew, more powerfully corrected by mere diſtilled vinegar, than by many famous ſtomachic and cordial elixirs, and other elaborate preparations; and ſometimes a ſeemingly improper addition may not only correct, but give new and unexpected virtues to a drug. Thus, though *ſublimatum corroſivum* be a mercurial concrete ſo fretting, that a very few grains of it may be able to kill a man; yet, by adding, and carefully uniting to it about an equal weight of running mercury, there is obtained, when they are well united by ſublimations, a compound, that is ſo free from being corroſive, that chymiſts call it *mercurius dulcis*; which though ſome unwary practitioners, as well Galeniſts as chymiſts, have too often, by their miſemployment of it, diſcredited, yet experience ſhews, that in ſkilful hands it may be uſefully employed, not only in ſome venereal affections, but in divers other diſtempers: and I ſhall now add, that being carefully prepared, and well given, it may not only be freed from corroſiveneſs, but much allay the ſharpneſs both of ſome emptying medicines, and of ſome peccant humours. To countenance the latter part of which obſervation, I ſhall acquaint you with one uſe of it, that perhaps you have not yet made. I remember, I had an opportunity to obſerve the efficacy of *mercurius dulcis*, in a ſtubborn dyſentery, that had baffled the remedies of an antient phyſician. But though a reflection on the virtue I knew this medicine to have of allaying ſharp humours, and reſiſting putrefaction, may juſtly increaſe my favourable opinion of it; yet not thinking my experience competent, I imparted it to an antient and expert chirurgeon, that was the chief of thoſe, that belonged to a famous and judicious general of an army; who thereupon frankly confeſſed to me, that this was his great arcanum, wherewith he had cured many ſcores, or rather hundreds of ſoldiers in this general's army; only, whereas my way is to give from 8, or 10, to 12, or at moſt 15 grains of *mercurius dulcis* for a doſe, made up with ſome little rhubarb, *&c.* or other ingredient, that would make it work once, twice, or thrice with another patient, (for the dyſentery itſelf helps to carry off the medicine;) he, both to diſguiſe it, and to make it more eaſily takeable, made it up with ſugar and mucilage of gum-dragon into lozenges, whereof one might contain from near a ſcruple to half a drachm of the *mercurius dulcis*, of which he ordered the ſoldiers to take one at a time, without hindering their march, only bidding them have a great care, that nothing ſhould ſtick between their teeth, or in their throats.

3. BUT the efficacy of this ſimple preparation of mercury is much inferior to that more ſimple, although more tedious, preparation of gold, which was made the ſame way in two differing countries, by two dexterous phyſicians, both of them of my acquaintance. For though I had long been prejudiced (not without ſpecious grounds) againſt pretended *aurum potabile's*, and other boaſted preparations of gold, (for moſt of which I have ſtill no over-great eſteem,) yet, I ſaw ſuch extraordinary and ſurprizing effects of the tincture of gold I ſpeak of, upon perſons of great note, that I was particularly acquainted with both before they fell deſperately ſick, and after their ſtrange recovery, that I could not but change my former opinion for a very favourable one of ſome preparations of gold; and I ſhould have thought, that this medicine (as little compounded as it is,) could ſcarce be paid by a great ſtore of the noble metal, that afforded it, if it could have been made in great quantity, or without a great deal of pains and time. I can ſpeak thus circumſtantially, becauſe by the kindneſs of the artiſts, and the pains I had ſpent in working on the ſame ſubject they make their menſtruum of, I ſo far knew, and partly (by themſelves invited) ſaw, the preparation of it, that (to bring home what has been ſaid to the preſent occaſion) I can tell you, that there is no ingredient aſſociated to the gold, ſave one, that comes from above, and is reputed one of the ſimpleſt bodies in nature, and of which one may take two or three ounces altogether unprepared, without the leaſt inconvenience; and yet the doſe of this almoſt inſipid medicine, that was given to an old courtier, even in a violent apoplexy, wherein other remedies had by ſkilful men been uſed in vain, was but ſix or eight drops.

IN another very antient and corpulent perſon the doſe was greater, becauſe the tincture was more unripe and diluted; but the effect was as ſudden, though the patient was not bled, and though there was not in either of theſe two caſes any notably ſenſible evacuation made. [Both theſe recovered perſons are yet alive.] The ſame medicine a while after ſaved the life of another gentleman I know, who, having lain above two and twenty days ſick of an ill conditioned fever, was condemned by three phyſicians, whereof one told me with great grief, that he would not out-live the next morning; and yet upon the taking of a large doſe of this tincture, he was preſently relieved, and from that time found a ſenſible amendment towards a recovery, which he now injoys, though he were then reputed to be about, if not above, fourſcore years old. Some other odd effects of this remedy I could tell you of; but it has already much ſwelled this ſection; and yet I thought it not amiſs to relate theſe things to you both, becauſe they are very pertinent to the ſcope of it, and becauſe you may be, as I long was, prejudiced againſt medicines made of ſo fixed, and, as is ſuppoſed, unalterable a metal as gold.

4. THIS is not the only medicine made of that noble body, of which I have known very notable effects: but, becauſe they belong to another paper, I ſhall not particularly mention them in this; but paſs on to tell you, that the preparation of ſilver, that I have long ſince delivered in another book, though it may ſeem but ſlight, has been found very effectual, and much uſed by one of the eminenteſt phyſicians of this nation, to whom I recommended it, and who acknowledged to me, that he gave it to patients of very high quality, though diſguiſed, to avoid alarming thoſe, that are fearful of chymical medicines. And ſince that I gave it to a great lady, that was hydropical, and judged to be dangerouſly ill, with notable ſucceſs; and the cure has already for ſome years held good. But I confeſs to you, that I look upon copper, and its magiſtery blue vitriol, as a much nobler ſubject to make remedies of, than ſilver, and perhaps than gold itſelf. And if I were to make phyſic my profeſſion, there is no metal, which I ſhould ſo willingly beſtow pains upon,

The uſefulneſs of experimental philoſophy.

as copper, induced thereunto by the excellent and very extraordinary effects, (not all of them to be mentioned in this paper) that I have had opportunity to ſee of ſome remedies, which, though I could never learn how to make, I knew were made of that metal, or vitriol abounding in it, but firſt freed from all cruelticle violence. And for appeaſing pains, produced even by inveterate maladies, the laudanums, and other opiate preparations, that are preſcribed and praiſed in phyſicians and chymiſts books, and much uſed (oftentimes with good ſucceſs) in their practice, ſeem to me, becauſe of the ſtupor, and ſome other inconvenient ſymptoms they are wont more or leſs to be followed by, far inferior to the ſulphureous parts, as a chymiſt would call them, of ſkilfully prepared Venus; theſe being much more harmleſly and friendly anodynous. And I remember, that an empirick, to whom, at his requeſt, I taught a very uncertain way (for it rarely hits) of making a kind of ſulphur of vitriol alone, in the form of a brick coloured powder, came purpoſely to give me ſolemn thanks for the reputation he had gained by that medicine, of which, the firſt time he had the good luck to make it, he gave, as he was inſtructed, four or five grains of it to a woman, that could not ſleep, but had been for divers months raving mad, [maniaca;] which ſingle doſe not only gave her a good night's reſt, but brought her to talk ſenſe, when ſhe waked in the morning. I knew alſo a chymiſt, that was much courted, even by learned doctors, for an internal anodyne he uſed, and could ſell at almoſt what rate he pleaſed, to take off inveterate pains in the heads and ſhins of venereal patients; and the ſame perſon cured Venereal ulcers in a very ſhort time, only by ſtrewing on them an indolent powder: and though he was ſo ſhy, that he would not let even the phyſicians I recommended to him ſee his medicine, yet having one day been told of a kindneſs I had done him, unknown to him; he took it ſo well, that he not only allowed me to ſee and handle his medicine, but when I gueſſed, by the ponderouſneſs and effects of it, that it was ſome preparation of mercury fixt with ſulphur of Venus, he frankly acknowledged to me, that, though it would indure not only ignition, but a ſtrong and laſting fire, that in the former part of my conjecture (that the body of it was mercurial) I was in the right, and in the latter part I ſhot very near the mark; but added, that the true ſulphureous parts of Venus were in his way ſo difficult to be obtained, and required ſo much time, that he could ſeldom prevail with himſelf, (who indeed was voluptuous enough) to go through ſo troubleſome a work. And in effect I found, upon various trials, the conſtituent parts of that metal to be much more ſtrictly united, than the generality even of chymiſts imagine. For the extraordinary effects of this medicine I can refer you to the teſtimony of very ingenious men of your own profeſſion, (and probably acquaintance too.) And ſince I know you ſtudy *Helmont*, I preſume you will the more readily believe them, if I put you in mind of that notable paſſage, where he ſays: *Nihil æque victorioſe in humidum radicale agit atque primum ens cupri, vel ad vitam longam ſulphure vitrioli eſt benignius; ideoque ſulphur philoſophorum indigitat.* But my intended brevity forbids me to inſiſt longer on this metal, or to take notice of more than one other metal. And becauſe that of ſteel phyſicians as well as chymiſts make great variety of remedies, ſome of which are produced by preparations ſlight enough; and the like may be made of mercury, witneſs the remedy formerly commended againſt the worms; made of nothing but crude quickſilver barely decocted in common water: for this reaſon, I ſay, I ſhall pitch upon lead, whoſe calx diſſolved in ſpirit of vinegar affords, as you know, *Saccharum Saturni*; which, though ſo eaſy and ſimple a preparation, is a magiſtery, that has more virtues, than every phyſician knows, or perhaps ſo much as ſuſpects; eſpecially in mortifying ſharp humours in the eyes, which I have known or made it do ſometimes almoſt in a trice: but I do not think it ſafe to make the plantain or roſe-water it is to be diſſolved in, conſiderably ſtrong of it. And for burns, I have ſeldom ſeen any thing equal to it, and therefore have often uſed it upon myſelf, barely diſſolved in common, or elſe plantain water. But I fear it is not ſo ſafe as effectual in ſome inward diſtempers of the bowels, that are judged to be cauſed by acid humours, unleſs it be very warily and ſkilfully given. But as to its external uſe, I preſume I need not tell ſo ſkilful a doctor as you (NB) how great it is in healing, and in the mean time appeaſing, the pains of divers ſorts of ulcers. And there-I ſhall mention but one particular, which it is like you have not met with; namely, that I know a very antient and experienced perſon, who, beſides a vaſt practice otherwiſe, was chirurgeon to a great hoſpital; who profeſſing much kindneſs, and owning ſome obligation to me, confeſſed to me, that amongſt all the medicines he has tried to ſtop bleeding, and prevent accidents in amputations, that, which he ofteneſt uſed, and moſt relied on, is a ſolution of *Saccharum Saturni* in plantain water (or for a need in pure common water:) for having diſſolved ℥i. of the former in about a pint or pound of the latter, as ſoon as ever the limb or other part is taken off, he immediately applies ſtupes drenched in this liquor, as hot as the patient can well endure; and having bound them carefully on, he makes no haſte to take them off, but allows the medicine time enough to perform its operation: to countenance this I would tell you an odd experiment of mine, of the efficacy of a Saturnine liquor to reſiſt putrefaction in the bodies of animals, but that the relation would take up too much time.

5. Perhaps I need not tell you, that I could here mention divers other experiments, as well upon Saturn, as the other metals I have named above; but that my ſcope con-

fines me to ſuch preparations, as wherein the metalline ſubject is compounded but with very few others; and alſo, that of thoſe, that are more remote from ſimplicity, you may meet with ſeveral in ſome of my other papers, which I am not in this to defraud.

What has been above noted about metals, may be extended to minerals; namely, that when there is need to compound them, it may oftentimes be ſufficient to aſſociate them with one or two, or at moſt a very few auxillary ingredients, if I may ſo call them. This is apparent in ſeveral uſeful preparations of antimony, that are vulgarly enough known, to which divers may be added, that are made of common ſulphur by ſlight additions. Of which ſort, becauſe I elſewhere deliver ſeveral, I ſhall now mention but one, which though I have many years ago deſcribed in the hiſtory of colours, I ſhall not ſcruple to take notice of here, becauſe I there conſider not its medicinal virtues, which yet are very great, eſpecially in aſthmas and coughs, in which I do not remember, that I ever gave it without benefit to the patient; nor was it leſs ſucceſsful in the hands of phyſicians, that were willing to try it for me, eſpecially in thoſe of a perſon, who, though well furniſhed with choice remedies of his own, often came to me for a ſupply of this ſpirituous and penetrating tincture, with which he aſſured me he did notable things in aſthmatical caſes; and particularly in one, that was very obſtinate, and had laſted many years. But not having had quite ſo many opportunities, as I wiſhed, of giving it myſelf, I ſhall be glad, that further trial may be made of it by ſo ſkilful an adminiſterer as you; and therefore, leſt you ſhould not have the book lately referred to at hand, I ſhall here repeat, that our medicine is made of flowers of ſulphur, exactly mixed with an equal weight of finely powdered ſal armoniac, and ſomewhat more than an equal weight of good quicklime, ſeparately reduced to a ſubtile powder; for theſe three ingredients being diligently and nimbly mixed, and put into a retort to be placed in a ſand furnace, and fitted with a large receiver very well luted to it: this mixture, I ſay, being duly diſtilled in ſuch veſſels, will afford a blood-red and ſmoking ſpirit, exceeding ſulphureous both in ſmell and even mechanical operations. And in this diſtillation the ſulphureous parts ſometimes came over accompanied with ſuch ſtore of ſaline ones, that a good part of what paſt into the receiver ſhot into the form of a volatile ſulphureous ſalt. And I remember, that having, for curioſity's ſake, added to the fluid tincture a due proportion of an ardent ſpirit (ſuch as that of wine) exactly dephlegmed, I had a mixture (whether in the form of a coagucum or not) which afforded me ſome odd phænomena not here to be mentioned, and which we ſubled with a gentle fire to unite them into a compoſition, that may for diſtinction ſake be called *ſal trium regnorum*, becauſe it contains urinous particles, vinous ones, (and perhaps ſome of ſoot) and ſulphureous ones; whereof the firſt belongs to the animal, the ſecond to the vegetable, and the laſt to the mineral kingdom, as chymiſts are wont to ſpeak. But what virtues this ſalt (that would preſently gild ſilver,) and the ſpirit, that may be made to accompany it, may have in phyſic, I had not occaſion to try; but yet I have mentioned it upon the by, that you make uſe of it, if you think it worth while to do ſo; to which I ſhall here preſent you with no inducements, ſince I perceive, that the particulars abovementioned about ſimple preparations of gold and other metals have already made this ſection enormouſly great: and yet I hope you will not be diſpleaſed at it; ſince to ſo ſagacious a perſon as Dr. *F.* theſe paſſages may afford ſome not altogether uſeleſs hints; and at leaſt it is an encouragement to induſtry, to know, that the ſubjects a man works on are capable of affording excellent things.

SECT. VII.

1. I Foresee it may be objected againſt the frequent uſe of ſimple medicines, that oftentimes it happens, that a diſeaſe, or a morbific matter, is not the effect of a ſingle cauſe, but is produced by the concurrence of two, or perhaps more, cauſes; which producing ſeveral ſymptoms, it is not probable, that one ſimple drug will be able to anſwer thoſe different indications. This objection I confeſs is conſiderable, and there are caſes, wherein I acknowledge it to be ſo weighty, as to invite and warrant a phyſician to employ in them a medicine conſiſting of more ingredients than one or two; which I can admit without prejudice to my deſign, ſince I formerly declared I did not intend to perſwade you to confine yourſelf to ſimple remedies (ſo much as in the late ſenſe above intimated of that term,) but only to employ them, where they may ſuffice; and where they cannot, to make uſe of medicines, as little compounded as the caſe will permit.

2. But having premiſed this advertiſement, I preſume I may offer you two or three conſiderations, that may leſſen the force of the lately propoſed objection. And firſt, though I readily grant, that there are diſeaſes, whereof each may proceed from differing cauſes, and that a remedy may be available againſt it, when it is produced by one of thoſe cauſes, without being ſo, when it flows from another; yet, it may alſo eaſily happen, that in one caſe the diſeaſe may be cured by one ſimple medicine, and in another by a remedy not compounded: nay, it may alſo happen, that the ſame ſimple may cure a diſtemper, by which ſoever of the two cauſes it is produced. This I have in another paper endeavoured to make out. And what we ſee of the effects of the Jeſuit's powder, as they call it, in different kinds of agues, as tertians, quartans, *&c.* and of pacating medicines (moſt of which indeed owe their virtue to opium, but ſome are mineral, and have nothing of the poppy in them) in appeaſing pains produced by humours, and other cauſes very differing; may keep what has been ſaid

from appearing improbable: and, if I miſtake not, it may divers times happen, that whatever it were, that at firſt produced a portion of morbific matter, that firſt produced matter is the cauſe of the continuance of the diſeaſe, by virtue of ſome peculiar texture or noxious conſtitution, which if a generous medicine can deſtroy, the diſeaſe will, at leaſt little by little, ceaſe.

3. It not unfrequently happens, that ſeveral ſymptoms, that ſeem very differing, may ſo depend upon the primary or principal cauſe of the diſeaſe, that if a medicine, how ſimple ſoever, be capable to deſtroy that cauſe, all the various ſymptoms will, by degrees at leaſt, vaniſh of themſelves; as we often ſee, that when mercury, though perhaps but crude, is ſkilfully applied, and raiſes a kindly ſalivation, a great variety of inconveniencies, that afflicted a Venereal patient, and ſeemed to require many differing and topical applications, are removed by the ſame remedy; inſomuch that not only frightful ulcers, but ſuch nodes, as one would think ſcarce poſſible to be diſſipated by the ſtrongeſt plaiſters, are ſometimes happily cured by well prepared quickſilver taken in at the mouth, as I have been aſſured by more than one eminent phyſician upon his own experience: and though not unfrequently there be ſeveral, and ſometimes very different ſymptoms, that accompany that diſeaſe of children, that in *England* we call the rickets, (and of which there die ſeveral almoſt every week in *London* alone;) yet that medicine, which I have elſewhere deſcribed under the name of *Ens (primum) Veneris* [made of ſtrongly calcined and well dulcified colcothar of Dantzick vitriol, and elevated with ſal armoniac into the form of a reddiſh ſublimate] has proved, by God's bleſſing on it, ſo ſucceſsful, that partly by a ſiſter of mine, (to whom I communicated it) and partly by myſelf, and thoſe I directed to take it, or to give it, I think I may ſafely ſay, that two or three hundred children have been cured by it, and that almoſt always without the help of any other inward medicine, or uſing any topical application at all.

4. But the main thing, that I intended, by way of anſwer to the foreſeen objection, was, that in a ſimple medicine nature herſelf does oftentimes ſo well play the apothecary, as to render the compoſitions made in his ſhop unneceſſary. For though we are wont to look upon this or that plant or mineral, as an entire and ſimple body, yet we may much miſtake, if we look upon it as a homogeneous one. In ſeveral plants, that are organical bodies, this truth is manifeſt; as for inſtance, in oranges the ſucculent part is ſour and cooling, but the yellow rind conſiderably bitter and hot: and ſo in lemons the pulp, the yellow part of the rind, and the ſeeds have their differing qualities and medicinal virtues. And even in ſuch vegetable ſubſtances, as are homogeneous as to ſenſe, there may be parts, whoſe operations may be not only differing, but contrary; as is manifeſt in the root we call rhubarb, which affords as well notably aſtringent, as laxative and purgative parts. And ſo in minerals themſelves, good and clean lead-ore, for inſtance, though an uniform body as to ſenſe, conſiſts of very diſſimilar parts, and affords ſulphureous and perhaps other recrements, beſides malleable lead, which is itſelf a compounded body. Thus alſo ſhining marcaſites, though they appear homogeneous, will, by barely being expoſed for a competent time to the moiſt air, afford an efforeſcence, that is perfectly vitriolate, and conſequently contains an acid ſalt, two kinds of ſulphur, a terreſtrial ſubſtance, and at leaſt one metal, (for oftentimes it holds both copper and iron, though one predominate,) which laſt named ſubſtances themſelves are neither of them ſimple bodies.

5. And if we admit the chymical analyſis of mixts to be genuine, we ſhall find, that almoſt all thoſe, that belong to the vegetable kingdom, or to the animal, and many that are referred to the mineral kingdom, how uniform ſoever they may appear to the eye, do each of them contain ſeveral different, and ſometimes hoſtile ſubſtances. Thus hartſhorn, though it appears a dry and homogeneous ſubſtance, will in diſtillation afford a volatile ſalt, an urinous ſpirit, a wateriſh liquor, or phlegm, a ſwimming oil and a ſinking one, a white and porous earth, or *terra damnata*, and perhaps ſome, though but very little, fixt ſalt. Thus alſo in the vegetable kingdom, tartar, for inſtance, may without addition be made to afford, as experience hath aſſured me, a volatile ſalt very like that of urine, a phlegm, an acid ſpirit, another ſpirit; to which I have elſewhere given the name of *Adiaphorous*, two fœtid oils, whereof one will ſink in water, and the other ſwim on it, an earth or *terra damnata*; and a fixt lixivial ſalt, upon which the newly mentioned acid ſpirit manifeſts ſuch a hoſtility, that when they are put together, they tumultuate with noiſe and bubbles, and in the conflict mortify each other. And thus likewiſe in the mineral kingdom, not to repeat what I lately ſaid of the compoundedneſs of vitriol, nor confidently to urge the opinion of divers eminent phyſicians, that *Mars* (as they call ſteel and iron) affords parts, whereof ſome are aſtringent and others operative, becauſe I am not yet ſure theſe contrary qualities do not proceed from the differing degrees of fire, and other circumſtances of the preparations of the metal; we ſee, that native cinnabar affords, by diſtillation, beſides running mercury, a dry ſubſtance, whence I have obtained a ſulphur, that would preſently gild ſilver, and a terreſtrial ſubſtance, whoſe nature I had not occaſion to examine. And I the rather take notice of theſe differing parts in native cinnabar, becauſe it is a mineral, that I much eſteem; and though here in *England* it is very rarely, or ſcarce at all employed as an inward medicine, yet I know ſome foreign phyſicians of ſeveral nations, that look upon it, as one of their chief arcanums, and both uſe it, and conceal it, accordingly. But I do not willingly employ it, till it has been prepared, by grinding it exactly upon a porphyry, or

other fit ſtone, as a painter would do to make a pigment of it, and by freeing it from certain ſalts, that often undiſcernedly adhere to it, and ſometimes may be hurtful; which is done by firſt waſhing it very carefully with boiling water, and then, after it has been throughly dried, by burning upon it ſeveral times, one after another, ſome vinous ſpirits perfectly dephlegmed. The doſe, if it be to be long continued, may be three, four or five grains; but when it is to be given but ſeldom, and, for an urgent caſe, it may be from ſix or ſeven to ten or twelve grains.

SECT. VIII.

1. WHAT has been ſaid in the foregoing diſcourſe, to manifeſt, that a ſimple, whether organical or not, may, notwithſtanding its intireneſs, or its ſeeming homogenity, contain or afford very diſſimilar parts, may help us to conceive, that being really a compounded body, it may afford parts differing enough to anſwer differing indications, or attain ſeveral ſcopes, that are wont to be looked on by phyſicians as neceſſary, or at leaſt very uſeful to the cure of this or that diſeaſe; as in many diarrhæas, or fluxes of the belly, whereas it is judged requiſite firſt to evacuate the peccant matter, and then to give aſtringents to hinder the immoderate evacuation, wherein the diſeaſe is thought to conſiſt; rhubarb anſwers both thoſe indications, by its purgative and its more terreſtrial parts, whereof the former diſpatch their work firſt, which makes the aſtringent operation of the latter ſeaſonable and ſafe.

2. I HAVE divers times obſerved, that ſo common and deſpicable a ſimple, as ground-ivy, has performed things, whoſe variety ſeemed to argue, that it contains parts of very differing virtues, (as of opening, contemperating, healing, *&c.*) and is thereby capable of anſwering differing intentions, eſpecially in diſtempers of the lungs and breaſt; and indeed partly by the ſyrup of it, partly by the infuſion of the leaves, and partly by medicines made of them in a conſiſtent form; the happy effects of this ſimple have procured me the thanks of divers conſiderable perſons, ſome of which had before unſucceſsfully uſed many preſcriptions of learned men. And I remember I knew an ingenious perſon, who being maſter of a conſiderable manufacture, which was gainful to him, whilſt his ſervants continued tolerably well, was very much incommodated and perplexed to find them ſo obnoxious to violent cholicks, (which he imputed to the copious ſteams of the vinegar his art required) that he was forced, almoſt weekly, to allow them ſome days of ceſſation from working, to preſerve or recover themſelves: and I remember, that from this inconvenience he was at length, as himſelf confeſſed to me, in great part freed, by making his workmen frequently uſe a ſtrong infuſion, or tincture of the leaves of our ground-ivy, made with (not pure or dephlegmed ſpirit of wine, but) good unrectified *Nantes* brandy.

I COULD here add divers other uſes, both internal and external, of this ſeeming deſpicable plant, there being ſcarce any one Engliſh herb known to me, of which, for its manifeſt virtues, the experience of others and my own have given me a greater eſteem. And I am apt to think, that the efficacy, which this and ſome other ſimples, that the fear of prolixity makes me ſilently paſs by, would be found both greater and more various, than they are commonly thought, if phyſicians, in preſcribing medicines, would more often either ordain ſimple ones, or, at leaſt, aſſociate but very few together, and compenſate the ſmall number of ingredients by the greater quantity of thoſe, that are the moſt appropriated or operative, and by perſiſting in their uſe for a competent time.

THOUGH it is not every efficacious ſimple, or but lightly compounded remedy, that can fitly be employed about the proof of what I am now endeavouring to ſhew, yet I ſhall ſubjoin ſuch inſtances, as will, I hope, ſuffice for the preſent occaſion.

MINERAL waters, as well *acidulæ*, as the German Spa, our *Tunbridge*, *&c.* as *thermæ*, ſuch as thoſe of *Bath*, *&c.* though but natural medicines, and ſome of them but outwardly adminiſtered, are notoriouſly known in their native ſimplicity to be able, one of them ſingly, frequently to cure diſeaſes, and conſequently to take off a good number of differing ſymptoms, that afford various indications. It may help much to make it probable, that the ſame ſimple may compriſe qualities fit to anſwer differing ſcopes, and thereby cure differing ſymptoms, if it be conſidered, that there are ſeveral poiſons, that do each of them produce ſymyptoms, not only very frightful, but very various, and yet all theſe have been oftentimes conquered by a ſpecific antidote, that is perhaps but a ſimple herb, or other uncompounded drug. I had once, (and but once) the opportunity of making a trial, whereof I ſhall now give you a brief account, of the virtue of a ſtone taken out of the head of an enormouſly great *African* ſerpent; which ſtone was affirmed to the poſſeſſor of it, governor of the famous Engliſh *Eaſt India* company, to be highly available againſt the bitings of all venomous animals. The ſubſtance of the experiment (to give it you in ſhort) was this: I cauſed a young cat to be bitten by a fierce and highly irritated viper, which ſo enraged the cat, that, in revenge, he endeavoured to bite off her head, which he took in his mouth, and did not let go, till, as the ſpectators concluded, ſhe had bit him again, at leaſt by the tongue: ſoon after which venomous hurt, the cat's head ſwelled very much, and though he ſoon grew ſo weak, that he was not able to ſtand on his legs, but lay along on the ground, yet he ſeemed to be grown quite mad, for he foamed at the mouth, and ſnapped at the end of a wand, or ſuch like things, that were but held near him; and, which was more, in his rage bit one of his own legs, that lay not far from his mouth, much to the ſurprize of the ſpectators: but, though in this deſperate condition it ſeemed in vain to attempt any thing for his reſcue, becauſe one could make him take nothing, and every one was afraid to come near him; yet having mixed a little of the powdered ſtone with ſome ſpoonfuls of fair water, it was by the help of the neck of a glaſs retort, that we employed inſtead of a funnel, poured, by degrees, upon the cat's mouth, which lying open, though he endeavoured to ſhake it off, yet ſome of it was concluded to have got in; and within one hour or two after, if not leſs, he did, to the no ſmall wonder of the by-ſtanders, get upon his legs again, and not only ſeemed to have loſt much of the tumidneſs of his head, but readily enough took the medicine I cauſed to be given him; and would probably have eſcaped very well, if, whilſt I was at dinner with the company, ſome unruly people had not hurt him more mortally than the viper had done.

PHYSICIANS and others have obſerved in the plague a great variety of ſymptoms, among which there are divers, whereof each, if ſingle, would paſs for a particular diſeaſe. And this diverſity of ſymptoms may be not unfrequently obſerved, not only in peſtilences, that happen at times, or in countries, diſtant from one another, but in the ſame plague reigning in the ſame place: and yet it is poſſible, that a ſimple remedy may be available againſt this ſo multifarious, or manifold (if I may ſo call it) and violent a diſeaſe. Of which obſervation (to omit what might be alledged out of ſome other authors) I ſhall give one inſtance out of *Galen* himſelf, who treating at large of the *terra Samia*, takes occaſion to bring in the virtues of bolarmony (*bolus Armena*) which I ſhould gueſs, by his manner of mentioning it, to have been little, if at all, known to phyſicians, till his time. This earth, that appears a body ſo ſimple and uniform, he not only commends for ſeveral diſeaſes, as ſpitting of blood, fluxes of the belly, dyſenteries, catarrhs, defluxions from the head upon the breaſt, difficulty of breathing thence enſuing, and even ulcers of the lungs; but adds, what makes very much and directly for our purpoſe, in the following words: *in magna hac peſte*, (whereof he had ſpoken before) *cujus eadem facies fuit atque ejus quæ Thucydidis memoria graſſabatur, quotquot hoc bibere, celeriter curati ſunt.* The way of giving it (which I add by the by, becauſe it may ſometime or other be of uſe) was this; *bibitur*, ſays he, *ex vino albo conſiſtentiâ tenui, modice diluto, ſi aut planè febri careat, aut leviter eâ teneatur*; *ſin gravius febriat, admodum aqueo.* And ſo excellent a medicine did this ſimple one prove in that terrible plague, that our author ſays, *Quibus non profuit, omnes interiere*; ſcil. *cum nec alio quovis medicamine, juvarentur: unde colligiter*, concludes he, *quod iis duntaxat non fuerit auxilio, qui plane erant incurabiles.*

Galen de Simpl. Med. Fac. lib. 9. *Tit. de Terra Samia.*

3. THERE are few diſeaſes, that put on ſo many forms, or are attended with greater variety of ſymptoms, than that, which phyſicians call *affectio hyſterica*, and whoſe paroxyſms, or effects, are vulgarly known in *England* by the name of fits of the mother. And yet we have often removed, and not ſeldom in a quarter of an hour, or leſs, hyſterical paroxyſms and ſymptoms, and ſometimes ſuch, as made the patient ſwoon, or lye along as almoſt dead, by the bare odour of well rectified ſpirit of harts-horn, or the mere pungent and powerful ſmell of a ſpirit of ſal-armoniac, which, by a peculiar way, I made very ſtrong, purpoſely for external uſes. And if I had not, out of the experienced *Monardes*, phyſician to the viceroy of the *Spaniſh Indies*, already mentioned in another treatiſe an antiſcorbutical gem, I would here add another remedy againſt the ſame diſeaſe, more conſiderably to my preſent purpoſe, ſince it is only a ſimple ſtone outwardly applied.

See *Nicol. Monard. Simpl. Med. Hiſt. c.* 36. *p. m.* 329.

4. BUT, becauſe I think not fit in this place, to inſiſt on a teſtimony already alledged, though its credibility, as well as that of the thing to be confirmed by it, may be much favoured by what has been related, concerning the virtues of ſtones outwardly applied, in the latter part of the diſcourſe about ſpecifics: for this reaſon, I ſay, I ſhall add a couple of other remarkable inſtances, of the efficacy of even dry and ſolid bodies, though but externally applied in diſeaſes attended with ſeveral, and divers of them uncommon ſymptoms, whereof, whatever many think of the harmleſneſs of our Engliſh vipours, I have here known ſeveral inſtances, in men as well as brutes. And yet in theſe dangerous caſes, many, that come from *Eaſt India*, extol the great efficacy of ſome of thoſe ſtony concretions, that are ſaid to be found in the heads of a certain kind of ſerpents about *Goa*, and ſome other Eaſtern countries: for though moſt phyſicians reject or queſtion the power aſcribed to theſe ſtones, for curing the bitings of vipers; and though I do not wonder at their diffidence, becauſe, in effect, many of the ſtones brought from *India* are but counterfeit, and of thoſe, that were really taken out of ſerpents, ſeveral, for a reaſon I muſt not ſtay to mention, are inſignificant, (and ſuch perhaps were thoſe, that the learned and curious *Redi* made his trials with) yet there are others, whoſe virtues are not well to be denied. For, not to build on vulgar traditions, which are but too often deceitful, one of the eminenteſt doctors of the *London* college aſſured me, that he had, with one of theſe ſtones, done, though contrary to his expectation, a notable cure, which he related to me at large. And one of our chief Engliſh chirurgeons affirmed to me, that he had done the like upon another perſon; both of theſe cures being performed by the bare application of the ſtone to the place bitten by the viper or adder. And a very intelligent perſon, who had the direction of a conſiderable company of traders in *Eaſt India*, where he long lived, aſſured me, that he had, with this ſtone, cured ſeveral perſons of the hurts

of venomous animals. But this teſtimony is much leſs conſiderable, as to the number of cures, than that of a great traveller into the Sourthern parts of the ſame *India*, who, though he were bred by a famous Carteſian philoſoſopher, and were forward enough to diſcredit vulgar traditions about the countries he had long lived in; yet being, for thoſe reaſons, aſked by me, what I might ſafely believe of the ſtones I ſpeak of, ſeriouſly affirmed to me, that he had cured above threeſcore perſons of the bitings or ſtings of ſeveral ſorts of poiſonous creatures; and that he performed moſt of thoſe cures by the outward application of one ſtone, becauſe, finding it excellent, he was invited to keep to it, eſpecially in difficult caſes. And this ſame experience of my own made with a genuine ſtone of this kind, upon the bodies of brutes, much inclines me to give credit to it. But, becauſe this ſtone is afforded by an animal, I ſhall add the virtues of another, that properly belongs to the mineral kingdom, in a diſeaſe, whoſe ſymptoms, though not ſo various, are ſometimes dangerous, and too often mortal.

To ſhew you then, that in ſpite of great cloſeneſs and hardneſs, a ſimple remedy outwardly applied may be a very effectual one, I ſhall inform you, that though the ſtone I am ſpeaking of paſt for a bloodſtone, yet by its colour, and ſome other viſible qualities, I ſhould rather have taken it for an agat. It was but about the bigneſs of a ſmall nutmeg, and had in it a perforation, by which a ſtring paſt through it, to faſten it to the part affected. This ſtone had been long kept in the family, that poſſeſſed it, when I ſaw it, being, for its rare virtues, left by one to another. But, to omit the reports, that went of it, the notable caſe, that makes it pertinent for me to mention it here, was this: an ingenious gentleman, that was a man of letters, and, when I ſaw him, was in the flower of his age, and of a complexion ſo highly ſanguine, as is not uſually to be met with, was, from time to time, ſubject to hemorrhages at the noſe, ſo profuſe and ſo difficult to be reſtrained, that his phyſician, though a perſon famous, and very well ſkilled in his art, told me he often feared he ſhould loſe his patient, and that he would be carried away by this unbridled diſtemper. But when good method and variety of remedies had been tried, without the deſired ſucceſs, this ſtone was at length obtained from an antient kinſwoman of the gentleman's, to tie about his neck, ſo as to touch his naked ſkin. This when he did in the fits, it would ſtop the bleeding; and if he wore it for ſome conſiderable time together, he all that while continued well, as both his learned phyſician and himſelf informed me. And, becauſe I was apt to aſcribe ſomewhat of this effect to imagination, the patient told me, that, a while before, one of the chief women in the city, (whom he named to me) fell into ſo violent a bleeding, that, though it brought her into a ſwoon, yet that itſelf, which is ſomewhat ſtrange, did not hinder her to bleed on, till the ſtone, having been tied about her neck, made her ceaſe to do ſo, though ſhe knew nothing of its having been applied to her. And this itſelf is leſs ſtrange, than what the gentleman affirmed to me of the power of this gem, as it may deſervedly be called: for his complexion inclining him, as was above intimated, to breed great ſtore of blood, his doctor thought fit to order him, for prevention, to breath a vein from time to time; which when he was about to do, he was obliged to lay aſide the ſtone for a while, becauſe, whilſt he kept it on, the blood would not iſſue out, at leaſt, with the requiſite fredom.

BUT how far have I already paſt beyond the deſigned limits of this little tract! wherein I at firſt intended but to lay before you the five chief advantages, I had obſerved mere ſimple remedies to have of very compounded ones; and briefly to propoſe the main grounds, on which I aſcribed thoſe advantages to ſuch remedies. But though the better to keep this writing from being prolix, I deſigned, that it ſhould conſiſt of ſuch particulars, as I could beſt ſpare from other papers; and though, for that reaſon, I have purpoſely omitted many parable, and other but little compounded or elaborate medicines; yet I now perceive, that ſo many new particulars having offered themſelves, on ſeveral occaſions, whilſt I was writing, my pen has ſlipt into the mention of many more receipts and hiſtorical paſſages, than were at firſt intended: but believing the ſubject to be very uſeful, and not deſpairing but that the things delivered on it may not be altogether uſeleſs, I dare hope you will pardon ſuch faults, as only my deſire of making the parts of this ſmall writing rather ſerviceable, than methodical, or well proportioned, drew me unawares into. But whatever were the cauſe of my prolixity, the bulk, which I ſee this paper has already ſwelled to, admoniſhes me, that I ought to put a ſpeedy period to it, without ſpending time ſollicitouſly to declare in what ſenſe I commend the medicines delivered in this invitation. For by recalling to mind what I have formerly wrote (in a treatiſe you have been pleaſed to peruſe*) about the limitations, with which I would have the praiſes I give of ſome remedies underſtood, and the cautions, with which I would have them adminiſtered; you will eaſily be perſuaded, that looking upon them but as fit tools in a ſkilful workman's hands, I do not pretend, that any of them ſhould do the offices both of phyſic and phyſician too; and that I propoſe not the medicines mentioned in this ſhort paper, as ſure ſpecifics, but as inſtances, that there are remedies, which, notwithſtanding their being but ſimple ones, may be very good ones.

I am, SIR, your moſt, &c.

R. B.

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* See the Appendix to the firſt ſection of the ſecond part of the *Uſefulneſs of Experimental Philoſophy*. p. 389, 390. and of the ſecond edition.

OF THE

High Veneration MAN's INTELLECT
OWES TO
GOD,
PECULIARLY FOR
His WISDOM and POWER.

ADVERTISEMENT.

THE abrupt beginning of the following paper will not (it is hoped) be wondered at, when it is declared, that the whole excurſion is to be looked upon as a fragment of a diſcourſe, from which, for certain reaſons, it has been ſeparated in its preſent form; in which it ought to paſs but for a rough draught, the nobleneſs, ſublimity, and ſacredneſs of the ſubject not allowing the author to preſume, that the firſt thoughts he committed to paper about it, might be for good and all parted with by him, till he ſhall have heedfully reviſed and corrected them, and left in them as few faults, as the diſproportion of ſo vaſt and ſublime a ſubject to his ſlender abilities will permit. The looſe ſheets this paper conſiſt of having been written at ſomewhat diſtant times and places, and haſtily tacked together, ſo that when the latter ſheets were penning, the former were often not at hand; it is hoped, that if ſome few things ſhould chance to be either miſplaced or repeated, the fault will be thought venial, and be more eaſily excuſed, than it could in the author's circumſtances be avoided. And laſtly, notice is to be given, that thoſe other long paſſages, that are included in * paratheſes, may, with the author's conſent (or rather by his deſire) be ſkipped over, being but conjectural thoughts, written and inſerted for the ſake of a virtuoſo, that is a great friend to ſuch kind of adventurous ſpeculations.

* Such figures as theſe [ ].

Of the High Veneration MAN's INTELLECT owes to GOD.

1. UPON this occaſion I ſhall take leave to declare, that it is not without ſome indignation, as well as wonder, that I ſee many men, and ſome of them divines too, who little conſidering what God is, and what themſelves are, preſume to talk of him and his attributes as freely, and as unpremeditately, as if they were talking of a geometrical figure, or a mechanical engine: ſo that even the leſs preſumptuous diſcourſe, as if the nature and perfections of that unparalled Being were objects, that their intellects can graſp; and ſcruple not to dogmatize about thoſe abſtruſe ſubjects, as freely as about other things, that are confeſſedly within the reach of human reaſon, or perhaps are to be found among the more familiar objects of ſenſe.

2. THE preſumption and inconſiderateneſs of theſe men might be manifeſt by divers conſiderations, if I had leiſure to inſiſt on them; but at preſent I ſhall employ but theſe two: firſt, that it is probable, that God may have divers attributes, and conſequently perfections, that are, as yet, unknown to us: and ſecondly, that of thoſe attributes, that we have already ſome knowledge of, there are effects and properties, whoſe ſublimity or

abſtruſeneſs ſurpaſſing our comprehenſion, makes the divine cauſe, or author of them, deſerve our higheſt wonder and veneration.

3. To begin with the firſt of theſe: whereas there are two chief ways to arrive at the knowledge of God's attributes; the contemplation of his works, and the ſtudy of his word; I think it may be doubted, whether either or both of theſe will ſuffice to acquaint us with all his perfections.

4. For, firſt, though philoſophers have rationally deduced the power, wiſdom and goodneſs of God from thoſe impreſſes of them, that he hath ſtamped upon divers of his viſible works; yet ſince the divine attributes, which the creatures point at, are thoſe, whereof themſelves have ſome, though but imperfect, participation, or reſemblance; and ſince the fœcundity (if I may ſo ſpeak) of the divine nature is ſuch, that its excellencies may be participated or repreſented in I know not how many ways; how can we be ſure, that ſo perfect and exuberant a Being may not have excellencies, that it hath not expreſſed or adumbrated in the viſible world, or any parts of it, that are known to us?

5. This will be the more eaſily granted, if we conſider, that there are ſome of thoſe divine attributes we do know, which, being relative to the creatures, could ſcarce, if at all, be diſcovered by ſuch imperfect intellects as ours, ſave by the conſideration of ſome things actually done by God. As ſuppoſing, that juſt before the foundations of the viſible world were laid, the angels were not more knowing than men now are, they could ſcarce think, that there was in God a power of creating matter, (which few, if any at all of the *Peripateticks*, *Epicureans*, to omit others of the antient philoſophers, ſeem ever to have dreamed of) and of producing in it local motion; eſpecially conſidering the puzzling difficulties, that attend the conception of the very nature and being of the one and of the other: and much leſs (as far as we can conjecture) could the angels ſpoken of have known, how the rational ſoul and human body act upon one another. Whence it ſeems probable, that if God have made other worlds, or rather vortices, than that which we live in, and are ſurrounded by, (as who can aſſure us that he hath not?) he may have diſplayed in ſome of the creatures, that compoſe them, divers attributes, that we have not diſcovered by the help of thoſe works of his, that we are acquainted with. But of this more hereafter.

6. I readily grant, (that I may proceed now to the ſecond help to acquire the knowledge of the divine attributes) that the revelations God hath vouchſafed us in the holy ſcriptures (which we owe to that ſpirit, which
1 Cor. ii. 10. *ſearcheth all things, even* τὰ βάθη τοῦ Θεοῦ, *the depths of God)* have clearly taught us divers things concerning their adorable Author; which the mere light of nature either would not have ſhewn us at all, or would have but very dimly diſcovered to us. But the ſcripture tells us indeed, that the promulgators of the goſpel declared to men *the whole* Act. xx. 27.
counſel of God (as far as was neceſſary for their ſalvation) but never ſays, that they diſcloſed to them *the whole nature of God*; who is ſaid to *inhabit an unapproachable light*, 1 Tim. vi. 16.
which human ſpeculations cannot penetrate. Upon which ſcore perhaps it was, that the Jews would have the proper name of God to be ineffable, to ſignify, that his nature is incomprehenſible. And, though I will not adopt their opinion, yet I cannot but take notice, that it is, at leaſt, no mere Talmudical tradition, ſince we find not, that either our Saviour himſelf, or his apoſtles (who are introduced ſo frequently making mention of God in the new teſtament) expreſſed in ſpeaking either to him, or of him, the *nomen tetragrammaton* (or four-lettered name!) But not to inſiſt on conjectures; the ſcripture itſelf, that brings ſo much light to things divine, that the goſpel is called *light*, in the abſtract; the ſcripture, I ſay, informs us, that in this life *we know but in part, and ſee things but darkly, as in a glaſs*; and we 1 Cor. xiii. 12.
are ſo far from being able *to find out God to* Job. xi. 7.
perfection, as to his nature and attributes, that even the *ways* of his providence are to Rom. xi. 33.
us *untraceable*.

7. These are ſome of the conſiderations, that inclined me to think, that God may have attributes, that are not known to us. And this opinion perhaps will appear the more allowable, becauſe of what I am going to add in anſwer to a weighty objection: for I know it may be alledged, that beſides the two ways I have mentioned of attaining to the knowledge of God's attributes, there may be a third way preferable to both the others, and that is, by conſidering the idea of a Being ſupremely or infinitely perfect; in which idea it may be alledged, that all poſſible perfections are contained; ſo that no new one can be added to it. But though I readily grant, that this idea is the moſt genuine, that I am able to frame of the Deity, yet there may be divers attributes, which, though they are indeed in a general way contained in this idea, are not in particular diſcovered to us by it. It is true, that, when by any means whatſoever, any divine perfection comes to our knowledge, we may well conclude, that it is in a ſenſe compriſed in the comprehenſive notion we have of a Being abſolutely perfect; but it is poſſible, that that perfection would never have come to our knowledge by the bare contemplation of that general idea, but was ſuggeſted by particularities; ſo that ſuch diſcoveries are not ſo much derived from, as referred to, the notion we are ſpeaking of.

The paſt conſiderations have, I preſume, perſuaded you, that God may have, as divers attributes, ſo divers excellencies and perfections, that are not known to us. It will therefore now be ſeaſonable to endeavour to ſhew you, that of divers of the attributes, we know that he hath, we men have but an imperfect knowledge, eſpecially in compariſon of what he has of them; which is not to be wondered at, ſince he poſſeſſes them in a manner or a degree peculiar to himſelf, and far tranſcending that, wherein we men poſſeſs them, or rather ſome faint reſembances of them.

It would be very unſuitable to my intended brevity, and more diſproportionate to my ſmall abilities, to attempt the making this good, by inſiſting particularly on all the divine excellencies, that we are in ſome meaſure acquainted with. I therefore hope it may ſuffice to inſtance in a couple of the moſt known ones; God's power, and his wiſdom. Which two I pitch upon, as being thoſe, that men are wont to look on as the principal, and for which they have the greateſt admiration and reſpect, becauſe we are not able to confer them on ourſelves, as we think we can divers other virtues and perfections. For every man eaſily believes, that he may be as chaſte, as temperate, as juſt, and, in a word, as good, as he pleaſes, thoſe virtues depending on his own will; but he is ſenſible, that he cannot be as knowing, as wiſe, and as powerful, as he would: and thence he not irrationally concludes, that power and wiſdom flow from, and argue, an excellency and ſuperiority of nature or condition. The power and wiſdom of God diſplay themſelves by what he does in reference both to his corporeal and his incorporeal creatures.

Among the manifold effects of the divine power, my intended brevity will allow me to mention only two or three, which, though to diſcerning eyes they be very manifeſt, are not wont to be very attentively reflected on: the immenſe quantity of corporeal ſubſtance, that the divine power provided for the framing of the univerſe; and the great force of the local motion, that was imparted to it, and is regulated in it.

And firſt; the vaſtneſs of that huge maſs of matter, that the corporeal world conſiſts of, cannot but appear ſtupendous to thoſe, that ſkilfully contemplate it. That part of the univerſe, which has been already diſcovered by human eyes aſſiſted with dioptrical glaſſes, is almoſt unconceiveably vaſt; as will be eaſily granted, if we aſſent to what the beſt aſtronomers, as well modern as antient, ſcruple not to deliver. The fixt ſtars of the firſt magnitude, that to vulgar eyes look but like ſhining ſpangles, are by artiſts affirmed to exceed, each of them, above a hundred times in bigneſs the whole globe of the earth: and, as little as theſe twinkling ſtars appear to our naked eyes, they do (which probably you will think ſtrange) appear much leſſer through our teleſcopes, which, taking off thoſe falſe lights, that make them look to our maimed ſight as they are wont to be painted, ſhew them little otherwiſe, than as ſpecks or phyſical points of light. And the ſun, which is granted to be ſome millions of miles nearer to us than the other fixt ſtars are, though it ſeem at this leſſer diſtance not to be half a foot broad, is by the generality of mathematicians believed to be above a hundred and threeſcore times bigger than the earth; nay, according to the more recent calculations of ſome more accurate modern artiſts, it is eſtimated to be eight or ten thouſand times as big as the terraqueous globe, and by farther obſervation may perhaps be found yet much vaſter. And it plainly appears by the parallaxes and other proofs, that this globe of earth and water, that we inhabit, and often call the world, though it be divided into ſo many great empires, and kingdoms, and ſeas, and though, according to the received opinion, it be 5400 German leagues in circuit, and conſequently contain 10,882,080,000 cubic miles in ſolid meaſure, and according to the more modern obſervations have a greater circumference (amounting to above 26,000 miles;) yet this globe, I ſay, is ſo far from being, for its bulk, a conſiderable part of the univerſe, that without much hyperbole we may ſay, that it is in compariſon thereof but a phyſical point: nay, thoſe far greater globes of the ſun and other fixt ſtars, and all the ſolid maſſes of the world to boot, if they were reduced into one, would perhaps bear a leſs proportion to the fluid part of the univerſe, than a nut to the ocean. Which brings into my mind the ſentence of an excellent modern aſtronomer, that the ſtars of the ſky, if they were crouded into one body, and placed where the earth is, would, if that globe were placed at a fit diſtance, appear to us no bigger, than a ſtar of the firſt magnitude does. And after all this I muſt remind you, that I have been hitherto ſpeaking but of that part of the corporeal univerſe, that has been already ſeen by us: and therefore, I muſt add, that as vaſt as this is, yet all that the eye, even when powerfully promoted by proſpective tubes, hath diſcovered to us, is far from repreſenting the world of ſo great an extent, as I doubt not but more perfect teleſcopes hereafter will do. And even then the viſible part of the world will be far enough from reaching to the bounds of the univerſe; to which the Carteſians and ſome other modern philoſophers will not allow men to ſet any; holding the corporeal world to be (as they love to ſpeak) indefinite, and beyond any bounds aſſignable by us men.

8. From the vaſt extent of the univerſe, I now proceed to conſider the ſtupendous quantity of local motion, that the divine power has given the parts of it, and continually maintains in it. Of this we may make ſome eſtimate by conſidering, with what velocity ſome of the greater bodies themſelves are moved; and how great a part of the remaining bodies of the univerſe is alſo, though in a ſomewhat differing way, indowed with motion.

As for the firſt of theſe; the leaſt velocity, that I ſhall mention, is that, which is afforded by the Copernican hypotheſis; ſince, according to that, it is the earth, that moves from Weſt to Eaſt about its own axis, (for its other motions concern not this diſcourſe) in four and twenty hours. And yet this terraqueous globe, which we think ſo great, that we commonly call it the world, and which, as was lately noted, by the recenter computations of mathematicians is concluded to contain ſix or ſeven and twenty thouſand miles in circuit; ſome part of this globe, I ſay, moves at ſuch a rate, that the learned *Gaſſendus* confeſſes, that a point or place, ſituated in the æquator of the earth, does in a ſecond minute move about two hundred toiſes or fathoms; that is, twelve hundred feet: ſo that a bullet, when ſhot out of a cannon, ſcarce flies with ſo great a celerity.

9. But, as I was ſaying, the motion of the earth is the leaſt ſwift, that I had to mention; being indeed ſcarce comparable to the velocity of the fixt ſtars, if, with the generality of aſtronomers, we ſuppoſe them to move in four and twenty hours about the earth. For ſuppoſing the diſtance aſſigned by the famous *Tycho* (a more accurate obſerver than his predeceſſors) between us and the firmament to be fourteen thouſand ſemidiameters of the earth, a fixt ſtar in the æquator does, as *Mullerius* calculates it, move 3,153,333 miles in an hour, and conſequently in a minute of an hour, fifty two thouſand five hundred fifty five miles, and in a ſecond (which is reckoned to be near about a ſingle pulſation or ſtroke of the artery of a healthy man) 875 miles; which is about, if not above, three thouſand times faſter, than a cannon bullet moves in the air. It is true, that, according to the Ptolomean hypotheſis, a fixt ſtar in the æquinoctial doth in a ſecond move at moſt but three ſemi-diameters of the earth: but according to the learned and diligent *Ricciolus*, this velocity (of our fixt ſtars) is fifty times greater than in the Ptolomean hypotheſis, and threeſcore and ten times greater than in the Tychonian hypotheſis; for, according to *Ricciolus*, ſuch a fixt ſtar as we ſpeak of, moves in a ſecond minute (or one beating of the pulſe) 157282 German leagues, which amount to ſix hundred twenty nine thouſand one hundred twenty eight Engliſh miles.

See *Ricciol.* Almag. nov. *Lib.* IX. *Sect.* IV. *Cap.* VI.

And now I ſhall add (what poſſibly you have not obſerved) that that portion of the univerſe, which commonly paſſes for *quieſcent*, and yet has motion put into it, is ſo great, that, for aught I know, the quantity of motion diſtributed among theſe ſeemingly quieſcent bodies, may equal, if not exceed, the quantity of motion, the firſt mover has communicated to the fixt ſtars themſelves, though we ſuppoſe them whirled about the earth with that ſtupendous ſwiftneſs, that the Ptolemeans and Tychonians attribute to them. For I reckon, that the fixt ſtars and planets, or, if you pleaſe, all the mundane globes, whether lucid or opacous, of which laſt ſort is the earth, do all of them together bear but a ſmall proportion to the interſtellar part of the univerſe. And though I ſhould allow all theſe globes to be ſolid, notwithſtanding that it can ſcarce be proved of any of them; and the Carteſians think the ſun (which they take to be a fixt ſtar, and therefore probably of the ſame nature with the reſt) to be extremely fluid: though I ſhould, I ſay, grant this, yet it muſt be confeſſed, that each of theſe ſolid globes ſwims in an ambient fluid of very much greater extent, than itſelf is: ſo that the fluid portion of the univerſe will in bulk almoſt incomparably exceed the ſolid. And if we conſider, what is the nature of a fluid body, as ſuch, we ſhall find, that it conſiſts in having its minute parts perpetually and variouſly moved, ſome this way and ſome that way; ſo that though the whole body of a liquor ſeems to be at reſt, yet the minute parts, that compoſe that liquor, are in a reſtleſs motion, continually ſhifting places amongſt themſelves, as has been amply ſhewn in a late tract, intituled, the *hiſtory of fluidity and firmneſs*.

10. And becauſe the quantity of motion ſhared by the corpuſcles, that compoſe fluid bodies, is not uſually reflected on even by philoſophers, it will not be here amiſs to add, that how great and vehement a motion the parts of fluid bodies (perhaps when the aggregates of thoſe particles appear quieſcent) may be endowed with, we may be aſſiſted to gueſs, by obſerving them, when their ordinary motions happen to be diſturbed, or to be extraordinarily excited by fit conjunctures of circumſtances. This may be obſerved in the ſtrange force and effects of boiſterous winds and whirlwinds, which yet are but ſtreams and whirlpools of the inviſible air, whoſe ſingly inſenſible parts are by accidental cauſes determined to have their motion made either in a ſtraight or almoſt ſtraight line, or, as it were, about a common centre: but an inſtance, much more conſpicuous, may be afforded by a mine charged with gunpowder, where the flame, or ſome ſubtile æthereal ſubſtance, that is always at hand in the air, though both one and the other of them be a fluid body, and the powder perhaps be kindled but by one ſpark of fire, exerts a motion ſo rapid and furious, as in a trice is able to toſs up into the air whole houſes and thick walls, together with the firm ſoil, or perchance ſolid rocks, they were built upon.

11. But ſince the velocity of theſe diſcharged flames may be gueſſed at by that, which the flame of gunpowder impreſſes on a bullet ſhot out of a well charged gun, which the diligent *Merſennus*, who made ſeveral trials to meaſure it, defines to be about 75 toiſes, or fathoms (that is, 450 foot) in a ſecond, being the 60th part of a minute; if we admit the probable opinion of the Carteſians, that the earth and divers other mundane globes, as the planets, are turned about their own axes by the motion of the reſpective æthereal vortices or whirlpools, in which they ſwim, we ſhall eaſily grant, that the motion of the celeſtial matter, that moves, for inſtance, upon the remote confines of the earth's vortex, is by a vaſt exceſs more rapid, than that of the ſurface of the earth: and yet we formerly obſerved, that a place ſituated under the æquator does (if the earth turns about its own axis) move as ſwiftly as a bullet ſhot out of a cannon. But if we chuſe rather the Tychonian hypotheſis, which makes the firmament

with all the vaſt globes of light, that adorn it, to move about their common centre in 24 hours, the motions of the celeſtial matter muſt be allowed a far greater, and indeed a ſcarce imaginable rapidity.

THESE things are mentioned, that we may have the more enlarged conceptions of the power as well as wiſdom of the great creator, who has both put ſo wonderful a quantity of motion into the univerſal matter and maintains it therein, and is able, not only to ſet bounds to the raging ſea, and effectually ſay to it, hitherto ſhalt thou come, and no farther, and here ſhall thy proud waves be ſtay'd, but, (what is far more) ſo to curb and moderate thoſe ſtupendouſly rapid motions of the mundane globes and intercurrent fluids, that neither the unwieldineſs of their bulk, nor celerity of their motions, have made them exorbitate or fly out, and this for many ages; during which no watch for a few hours has gone ſo regularly; the ſun, for inſtance, moving, without ſwerving, under the ſame circular line, that is called the eclіptick. And if the firmament itſelf, whoſe motion in the vulgar hypotheſis is by much the moſt rapid in the world, do fail of exactly completing its revolution in 24 hours, that retardation is ſo regulated, that ſince *Hipparchus*'s time, who lived 2000 years ago, the firſt ſtar in Aries, which was then near the beginning of it, is not yet come to the laſt degree of that ſign.

12. AFTER what hath been diſcourſed of the power of God, it remains, that I ſay ſomething about his wiſdom; that being the attribute, to which thoſe, that have elevated underſtandings, are wont to pay the higheſt veneration, when they meet it even in men, where yet it is ſtill but very imperfect.

THE wiſdom of God which ſaint *Paul*
Eph. iii. 10. ſomewhere juſtly ſtiles πολυποίκιλος, manifold or multifarious, is expreſſed in two differing manners or degrees. For ſometimes it is ſo manifeſtly diſplayed in familiar objects, that even ſuperficial and almoſt careleſs ſpectators may take notice of it. But there are many
Col. ii. 3. other things, wherein the treaſures of wiſdom and knowledge may be ſaid to be hid; lying ſo deep, that they require an intelligent and attentive conſiderer to diſcover them. But though I think I may be allowed to make this diſtinction, yet I ſhall not ſolicitouſly confine myſelf to it; becauſe in ſeveral things both theſe expreſſions of the divine wiſdom may be clearly obſerved.

THOSE objects of this wiſdom, that we ſhall at this time conſider, are of two ſorts; the material and viſible, and the inviſible and immaterial creatures of God.

IN the firſt of theſe, whoſe aggregate, or collection makes up the corporeal world, commonly called univerſe, I ſhall briefly take notice of the excellent contrivance of particular bodies; of the great variety, and conſequently number, of them; of their ſymmetry, as they are parts of the world; and of the connexion and dependance they have in relation to one another. And though under the two firſt of theſe heads I might, as well as under the other two, take notice of many inanimate bodies, as well as of thoſe, that are endowed with vegetative and ſenſitive ſouls, (as naturaliſts commonly call them;) yet, for brevity's ſake, I ſhall here take notice only of that more perfect ſort of living creatures, that we call animals.

13. I. THE contrivance of every animal, and eſpecially of a humane body, is ſo curious and exquiſite, that it is almoſt impoſſible for any body, that has not ſeen a diſſection well made and anatomically conſidered, to imagine or conceive, how much excellent workmanſhip is diſplayed in that admirable engine. But of this having diſcourſed elſewhere more fully, I ſhall here only tell you in a word (and it is no hyperbole) that as St. *Paul* ſaid on another occaſion, *that the fooliſh things* 1 Cor. i. 25.
of God are wiſer than men, and the weak things of God ſtronger than men; ſo we may ſay, that the meaneſt living creatures of God's making are far more wiſely contrived, than the moſt excellent pieces of workmanſhip, that human heads and hands can boaſt of; and no watch nor clock in the world is any way comparable, for exquiſiteneſs of mechaniſm, to the body of even an aſs or a frog.

14. II. BUT God's wiſdom is recommended as well by the variety, and conſequently the number of the kinds of living creatures, as by the fabrick of each of them in particular. For the ſkill of human architects and other artiſts is very narrow, and for the moſt part limited to one or to a few ſorts of contrivements. Thus many an architect can build a houſe well, that cannot build a ſhip; and (as we daily ſee) a man may be an excellent clock-maker, that could not make a good watch, and much leſs contrive well a fowling-piece, or a wind-mill.

15. BUT now the great author of nature has not only created four principal ſorts of living engines, namely beaſts, birds, fiſhes, and reptiles, which differ exceedingly from one another, as the ſeveral regions or ſtages, where they were to act their parts, required they ſhould do; but under each of theſe comprehenſive genders are comprized I know not how many ſubordinate ſpecies of animals, that differ exceedingly from others of the ſame kind, according to the exigency of their particular natures. For not only the fabrick of a beaſt (as a lion) is very differing from that of a bird, or a fiſh, (as an eagle or a whale;) but in the ſame ſpecies the ſtructure or mechaniſm of particular animals is very unlike: witneſs the difference between the parts of thoſe beaſts, that chew the cud, and thoſe that do not; and between the hog and the hare, eſpecially in their entrails; and ſo between a parrot and a batt, and likewiſe between a whale, a ſtar-fiſh, a lobſter, and an oyſter, (to mention now no other inſtances.) And if with divers philoſophers both ancient and modern we admit vegetables into the rank of living creatures, the number of theſe being ſo great, that above ſix thouſand kinds of vegetables were many years ago reckoned up; the manifold diſplays of the

divine mechaniſm, and ſo of its wiſdom, will by that great variety of living engines be ſo much the more conſpicuous.

16. III. That, which much enhances the excellent contrivances to be met with in theſe automata, is the ſymmetry of all the various parts, that each of them conſiſts of. For an animal, though, conſidered in his ſtate of intireneſs, he is juſtly looked upon as one engine; yet really this total machine (if I may ſo call it) is a complex thing made up of ſeveral parts, which, conſidered ſeperately, may paſs each of them for a ſubordinate engine excellently fitted for this or that particular uſe: as an eye is an admirable optical inſtrument to enable a man to ſee; and the hand is ſo well framed for a multitude of mechanical uſes, that *Ariſtotle* thought fit to call it the organ of organs, (or inſtrument of inſtruments.) It ought therefore highly to recommend the wiſdom of the great *yotſer bakkol, former of all things* (as the ſcripture ſtiles him,) that he has ſo framed each particular part of a man (or other animal,) as not to let the ſkill beſtowed on that hinder him from making that part or member itſelf, and every other, neither bigger nor leſs, nor (in a word) otherwiſe conſtituted, than was moſt expedient for the completeneſs and welfare of the whole animal. Which manifeſts, that this great artiſt had the whole fabrick under his eye at once, and did at one view behold all, that was beſt to be done, in order to the completeneſs of the whole animal, as well as to that of each member and other part, and admirably provided for them both at once. Whereas many an excellent artificer, that is able to make a ſingle engine very complete, may not be able to make it a commodious part of a complex or aggregate of engines: as it is not every one, that can make a good pump, that can make a good ſhip-pump; nor every chymiſt, that can build an oven for a bakehouſe, that can make one fit to be ſet up in a ſhip: and we ſee, that our pendulum clocks, that are moved with weights, and go very regularly a-ſhore, cannot yet be brought to perform their office (of conſtantly meaſuring of time) when ſet up in a ſailing ſhip.

Jer. x. 16.

17. IV. The fourth way, by which God manifeſts his wiſdom in his corporeal creatures, is, their mutual uſefulneſs to one another, in a relation either of dependency or of co-ordination. This ſerviceableneſs may be conſidered, either as the parts of the animal have a relation to one another, and to the whole body they make up; or as intire and diſtinct bodies have reference to or dependency on each other. To the firſt ſort of utility belong the uſes of the parts of the human body, for inſtance, which are ſo framed, that beſides theſe publick offices or functions, that ſome of them exerciſe for the good of ihe whole, as the ſtomach for concocting aliments, the brain for ſupplying animal ſpirits to move the limbs, and other parts, the kidneys to ſeperate the ſuperfluous ſerum of the blood; there are many other particular parts, that have that ſubſerviency to one another, that no deſpicable portion of the books of anatomy is employed in the mention of them. And divers conſents of parts and utilities, that accrue from one to the other, are farther diſcovered by diſeaſes, which primarily affecting one part or member of the body, diſcover that this or that other part has a dependance on it, or a particular relation to it, though perhaps not formerly taken notice of. To the ſecond part of utility belong thoſe parts, that diſcriminate the ſexes of animals, which (parts) have ſuch a relation one to another in the male and the female, that it is obvious they were made for the conjunction of both in order to the propagation of the ſpecies. I cannot here ſpend time to conſider the fitneſs of the diſtance and ſituation of the ſun, the obliquity of its motion under the ecliptick, and (eſpecially) the compenſations, that nature makes by one thing for another, the exceſs of whoſe qualities would elſe be noxious to men, as the great heats and drineſs, that reign in many parts of the torrid zone and ſome neighbouring climates, would render thoſe countries barren and uninhabitable, as the ancients thought them, if they were not kept from being ſo, by the Eteſians and the trade-winds, which blow regularly (though not always the ſame way) for a great part of the hotteſt ſeaſons of the year, and are aſſiſted by the length of the nights, by the copious and laſting rains, that fall at ſet times, by the greatneſs of the rivers, (ſome of them periodically overflowing their banks to great diſtances) and by the winds, that in many places blow in the night from the land ſeaward, and in the morning from the ſea towards the land; for theſe, and ſome other ſuch things, do ſo moiſten and refreſh the ground, and contemperate the air, that in many of thoſe climates, which the ancients thought parched up and uninhabitable, there are large kingdoms and provinces, that are both fruitfull and populous, and divers of them very pleaſant too. But, as I was ſaying, I cannot ſtay to proſecute what might be repreſented to ſhew the uſefulneſs of many of God's other ſenſible works to the nobleſt kind of them, men. But I ſhall rather content myſelf, by adding a few lines, to point farther at the reference, that God has been pleaſed to make many other things have to the welfare of men and other animals; as we ſee, that, according to the uſual courſe of nature, lambs, kids, and many other living creatures, are brought into the world at the ſpring of the year, when tender graſs and other nutritive plants are provided for their food. And the like may be obſerved in the production of ſilk-worms, whoſe eggs, according to nature's inſtitution, are hatched, when mulberry trees begin to bud and put forth thoſe leaves, whereon theſe precious inſects are to feed; the aliments being tender, whilſt the worms themſelves are ſo, and growing more ſtrong

and ſubſtantial, as the inſects increaſe in vigour and bulk.

18. THERE is one thing, which though it might perhaps have been more properly brought in before, muſt not here be pretermitted. For beſides what was lately ſaid of the excellent fabrick of the bodies of men and other animals, we may deſervedly take notice, how much more wonderful, than the ſtructure of the grown body, muſt be the contrivance of a *ſemen animatum*; ſince all the future parts, (ſolid as well as ſoft) and the functions, and many of the actions (and thoſe to be variable *pro re nata*) of the animal to be produced, muſt be durably delineated, and, as it were, couched in a little portion of matter, that ſeems homogeneous, and is unqueſtionably fluid: and that, which much increaſes the wonder, is, that one of theſe latent impreſſions or powers, namely the plaſtick, or prolifick, is to lye dormant perhaps above thirty or forty years, and then to be able to produce many more ſuch engines as is the animal itſelf.

What is included in this Crochets, may be ſkipped.

[I HAVE hitherto, among the corporeal works of God, taken notice only of thoſe productions of his power and wiſdom, that may be obſerved in the viſible world: ſo that I may be allowed to conſider farther, that not only the Peripateticks, but the generality of other philoſophers, believe the world to be finite; and, though the Carteſians will not ſay it is ſo, but chuſe rather to call it indefinite, yet as it is elſewhere ſhewn, their opinion is rather a well-meant piece of modeſty, than a ſtrict truth. For, in reality, the world muſt every way have bounds, and conſequently be finite; or it muſt not have bounds, and ſo be truly boundleſs; or, (which is the ſame thing in other terms) infinite: and if the world be bounded, then thoſe, that believe a Deity, to whoſe nature it belongs to be of infinite power, muſt not deny, that God is, and ſtill was, able to make other worlds than this of ours. And the Epicureans, who admitted no omnipotent Maker of the world, but ſubſtituted chance and atoms in his ſtead, taught, that by reaſon the cauſes ſufficient to make a world, that is atoms and ſpace, were not wanting, chance has actually made many worlds, of which ours is but one; and the Carteſians muſt, according to their doctrine of the indefiniteneſs of corporeal ſubſtance, admit, that our viſible world, or, if they pleaſe, vortex, by which I mean the greateſt extent our eyes can reach to, is but a part, and comparatively but a very ſmall one too, of the whole univerſe, which may extend beyond the utmoſt ſtars we can ſee, incomparably farther than thoſe remoteſt viſible bounds are diſtant from earth.]

Now if we grant, with ſome modern philoſophers, that God has made other worlds beſides this of ours, it will be highly probable, that he has there diſplayed his manifold wiſdom, in productions very differing from thoſe, wherein we here admire it. And even, without ſuppoſing any more than one univerſe, as all that portion of it that is viſible to us, makes but a part of that vaſtly extended aggregate of bodies; ſo if we but ſuppoſe, that ſome of the celeſtial globes, whether viſible to us, or placed beyond the reach of our ſight, are peculiar ſyſtems, the conſideration will not be very different: for ſince the fixed ſtars are many of them incomparably more remote than the planets, it is not abſurd to ſuppoſe, that as the ſun, who is the fixed ſtar neareſt to us, has a whole ſyſtem of planets, that move about him; ſo ſome of the other fixed ſtars may be each of them the centre, as it were, of another ſyſtem of celeſtial globes; ſince we ſee, that ſome planets themſelves, that are determined by aſtronomers to be much inferior in bigneſs to thoſe fixed ſtars I was ſpeaking of, have other globes, that do, as it were, depend on them, and move about them; as, not to mention the earth, that has the moon for its attendant, nor Saturn, that is not altogether unaccompanied, it is plain, that Jupiter has no leſs than four ſatellites, that run their courſes about him. And it is not to be pretermitted, that none of theſe leſſer and ſecondary planets, (if I may ſo call them) that moves about Saturn and Jupiter, is viſible to the naked eye, and therefore they were all unknown to the antient aſtronomers, who lived before the invention of teleſcopes. Now, in caſe there be other mundane ſyſtems (if I may ſo ſpeak) beſides this viſible one of ours, I think it may be probably ſuppoſed, that God may have given peculiar and admirable inſtances of his inexhauſted wiſdom in the contrivance and government of ſyſtems, that, for aught we know, may be framed and managed in a manner quite differing from what is obſerved in that part of the univerſe, that is known to us. For, beſides that here on earth, the loadſtone is a mineral ſo differing in divers affections, not only from all other ſtones, but from all other bodies, that are not magnetical, that this heteroclite mineral ſcarce ſeems to be originary of this world of ours, but to have come into it by a remove from ſome other world or ſyſtem; I remember, that ſome of the navigators, that diſcovered *America*, took notice, that at their firſt coming into ſome parts of it, though they found great ſtore of animals and plants, yet they met with few of the latter, and ſcarce any of the former, of the ſame ſpecies with the living creatures of *Europe*.

19. Now in theſe other worlds, beſides that we may ſuppoſe, that the original fabrick, or that frame, into which the omniſcient architect at firſt contrived the parts of their matter, was very differing from the ſtructure of our ſyſtem; beſides this, I ſay, we may conceive, that there may be a vaſt difference betwixt the ſubſequent phænomena, and productions obſervable in one of thoſe ſyſtems, from what regularly happens in ours, though we ſhould ſuppoſe no more, than that two or three laws of local motion may be differing in thoſe unknown worlds from the laws, that obtain in ours. For if we ſuppoſe, for in-

ſtance, that every entire body, whether ſimple or compounded, great or ſmall, retains always a motive power, (as philoſophers commonly think, that the ſoul does, when it has moved the human body, and as the Epicureans, and many other philoſophers, think all atoms do, after they have impelled one another) this power of exciting motion in another body, without the movent's looſing its own, will appear of ſuch moment to thoſe, that duly conſider, that local motion is the firſt and chiefeſt of the ſecond cauſes, that produce the phænomena of nature, that they will eaſily grant, that theſe phænomena muſt be ſtrangely diverſified, by ſpringing from principal cauſes ſo very differingly qualified. Nor (to add another way of varying motion) is it abſurd to conceive, that God may have created ſome parts of matter to be of themſelves quieſcent, (as the Carteſians and divers other philoſophers ſuppoſe all matter to be in its own nature,) and determined to continue at reſt, till ſome outward agent force it into motion; and yet that he may have endowed other parts of the matter with a power like that, which the atomiſts aſcribe to their principles, of reſtleſly moving themſelves, without looſing that power by the motion they excite in quieſcent bodies. And the laws of this propagation of motion among bodies may be not the ſame with thoſe, that are eſtabliſhed in our world; ſo that but one half, or ſome leſſer part, (as a third) of the motion, that is here communicated from a body of ſuch a bulk and velocity, to another it finds at reſt, or ſlowlier moved than itſelf, ſhall there paſs from a movent to the body it impels, though all circumſtances, except the laws of motion, be ſuppoſed to be the ſame. Nor is it ſo extravagant a thing, as at firſt it may ſeem, to entertain ſuch ſuſpicions as theſe; for in the common philoſophy, beſides that the notion and theory of local motion are but very imperfectly propoſed, there are laws or rules of it well, not to ſay at all, eſtabliſhed.

20. And as for the Carteſian laws of motion, though I know they are received by many learned men, yet I ſuſpect, that it is rather upon the authority of ſo famous a mathematician as *Des Cartes*, than any convictive evidence, that accompanies the rules themſelves; ſince to me (for reaſons, that belong not to this diſcourſe) ſome of them appear not to be befriended either by clear experience, or any cogent reaſon. And for the rule, that is the moſt uſeful, namely, that which aſſerts, that there is always the ſame quantity of motion in the world, every body, that moves another, looſing juſt as much of its own, as it produces in the other: the proof he offers, being drawn from the immutability of God, ſeems very metaphyſical, and not very cogent to me, who fear, that the properties and extent of the divine immutability are not ſo well known to us mortals, as to allow *Carteſius* to make it, in our preſent caſe, an argument *à priori*. And *à poſteriori*, I ſee not, how the rule will be demonſtrated; ſince, beſides that it may be queſtioned, whether it is agreeable to experience in divers inſtances, that might be given of communicated motions here below; I know not what experience we have of the rules, by which motion is propagated in the heavenly regions of the world, among all the bodies, that make up the ætherial, (which is incomparably the greateſt) part of the univerſe. So that the truth of the Carteſian rules being evinced neither *à priori*, nor *à poſteriori*, it appears not, why it ſhould be thought unreaſonable to imagine, that other ſyſtems may have ſome peculiar laws of motion; only becauſe they differ from thoſe Carteſian rules, whereof the greateſt part are, at leaſt, undemonſtrated.]

21. But though, if we allow of ſuppoſitions and conjectures, ſuch as thoſe lately mentioned, that are, at leaſt, not abſurd, they may conduce to amplify ſome of our ideas of divine things; yet we need not fly to imaginary ultra-mundane ſpaces, to be convinced, that the effects of the power and wiſdom of God are worthy of their cauſes, and not near adequately underſtood by us, if, with ſufficient attention, we conſider that innumerable multitude, and unſpeakable variety of bodies, that make up this vaſt univerſe. For, there being among theſe a ſtupendous number, that may juſtly be looked upon as ſo many diſtinct engines, and many of them very complicated ones too, as containing ſundry ſubordinate ones; to know, that all theſe, as well as the reſt of the mundane matter, are every moment ſuſtained, guided and governed, according to their reſpective natures, and with an exact regard to the catholic laws of the univerſe; to know, I ſay, that there is a Being, that doth this every where, and every moment, and that manages all things, without either aberration or intermiſſion, is a thing, that, if we attentively reflect on, ought to produce in us for that ſupreme Being, that can do this, the higheſt wonder, and the lowlieſt adoration.

The Epicureans of old did, with ſome colour of reaſon, as well as with much confidence, urge againſt the belief of a divine Providence, that it is unconceivable, and therefore incredible, that the gods ſhould be ſufficient for ſuch differing and diſtracting employments, as, according to the exigencies of Nature's works, to make the ſun ſhine in one place, the rain ſhower down in another, the winds to blow in a third, the lightening to flaſh in a fourth, the thunderbolts to fall in a fifth; and, in ſhort, other bodies to act and ſuffer, according to their reſpective natures. Wherefore we, that, upon good grounds, believe, that God really does, what theſe philoſophers thought impoſſible to be done by any agents whatſoever, are much wanting in our duty, if we do not admire an all-pervading wiſdom, that reaches to the utmoſt extent of the univerſe, and actually performing what philoſophers profeſſed they could not ſo much as conceive, highly merits, that thoſe difficulties, which they thought inſuperable, and ſo a ſufficient excuſe for their unbelief, ſhould be a powerful motive to our veneration of that tranſcendent wiſdom, that without any trouble ſurmounts them.

22. WE have ſeen ſome diſplays of God's wiſdom as well as power, by what we have obſerved in his corporeal works: but it will be eaſily granted, that ſome of the divine perfections could not be ſo well expreſſed, or copied upon corporeal creatures, as upon the rational and immaterial ſoul of man, and other intellectual beings; as the picture of an apple or a cherry, or the character of a number, is not capable of receiving or containing ſo much of an excellent painter's ſkill, as he may exhibit in a piece, wherein the paſſions of the mind, and the laws of opticks, and of decency, may be fully expreſſed. And, it may well be preſumed, that if we were as familiarly acquainted with God's incorporeal creatures, as we are with his viſible ones, we ſhould perceive, that as ſpirits are incomparably more noble than bodies, ſo the Divine Wiſdom, employed in the government and conduct of them, is more glorious than that, which we juſtly admire in the frame and management of his corporeal works. And indeed, let a portion of matter be never ſo fine, and never ſo well contrived, it will not be any more than an engine devoid of intellect and will, truly ſo called, and whoſe excellency, as well as its diſtinction from other bodies, even the groſſeſt and imperfecteſt, can conſiſt but in mechanical affections, ſuch as the ſize, ſhape, motion and connexion of its parts; which can neither excite themſelves into motion, nor regulate and ſtop the motion they once are in: whereas true ſpirits, (by which I here mean immaterial ſubſtances) have, by God's appointment, belonging to their nature, underſtanding, will, and an internal principle, both of acting ſo and ſo, and of arbitrarily ceaſing from action. And though God, as the ſole creator of all ſubſtances, has, and, if he pleaſe, may exerciſe an abſolute dominion over all his creatures, as well immaterial as corporeal; yet ſince he has thought fit to govern ſpirits according to the nature he has given them, (which comprehends both underſtanding and will) to create ſuch intelligent, free and powerful beings, as good and bad angels, (to ſay nothing now of men) and to govern them on thoſe terms, ſo as effectually to make them (however they behave themſelves) inſtruments of his glory, which multitudes of them do as ſubtily, as obſtinately oppoſe; to do theſe things, I ſay, requires a wiſdom and providence tranſcending any, that can be diſplayed in the formation and management of merely corporeal beings: for inanimate engines may be ſo contrived, as to act but as we pleaſe; whereas angels and human ſouls are endowed with a freedom of acting, in moſt caſes, as themſelves pleaſe. And it is far eaſier for a ſkilful watch-maker to regulate the motions of his watch, than the affections and actions of his ſon.

23. AND here give me leave to conſider, that angels, whether good or bad, are very intelligent and active beings; and that each of them is endowed with an intellect capable of almoſt innumerable notions and degrees, or variations of knowledge, and alſo with a will, capable of no leſs numerous exertions or acts; and of having various influences upon the underſtanding, as (on the other ſide) it is variouſly affected by the dictates of it: ſo that, (to apply this conſideration to my preſent purpoſe) each particular angel being ſucceſſively capable of ſo many differing moral ſtates, may be looked upon, as, in a manner, a diſtinct ſpecies of the intellectual kind: and the government of one dæmon may be as difficult a work, and conſequently may as much declare the wiſdom and power of God, as the government of a whole ſpecies of inanimate bodies, ſuch as ſtones or metals, whoſe nature determines them to a ſtrict conformity to thoſe primordial laws of motion, which were once ſettled by the Great Creator, and from which they have no wills of their own to make them ſwerve.

THE ſcripture tells us, that in the œconomy of man's ſalvation there is ſo much of the manifold wiſdom of God expreſſed, that the angels themſelves deſire to pry into thoſe myſteries. When our Saviour, having told his apoſtles, that the day and hour of his future coming to judgment (whether of the Jewiſh nation or the world, I now inquire not) was not then known to any, ſubjoins, *no, not to the angels of heaven, but to his Father only*; Mat. xxiv. 36. he ſufficiently intimates them to be endowed with excellent knowledge, ſuperior to that of men; and that perhaps may be one of the reaſons, why the ſcripture ſtyles them angels of light. It alſo teaches us, that the good angels are vaſtly numerous, and that as they are of differing orders, ſome of them being arch-angels, and ſome princes of particular empires or nations; ſo God aſſigns them very differing and important employments both in heaven and in earth; and ſometimes ſuch as oblige them, in diſcharge of their reſpective truſts, to endeavour the carrying on of interfering deſigns. The ſame ſcripture by ſpeaking of the devil and his angels, and of the great dragon, that drew down with his tail the third part of the ſtars from heaven to earth, and by mentioning a whole legion of devils, that poſſeſſed a ſingle man, and by divers other paſſages, that I ſhall not now inſiſt on, giving us ground to conclude, that there is a political government in the kingdom of darkneſs; that the monarch of it is exceeding powerful, whence he is ſtyled the prince of this world, and ſome of his officers have the titles of principalities, powers, rulers of the darkneſs of this world, &c. Eph. vi. 12. that the ſubjects of it are exceeding numerous; that they are deſperate enemies to God and men, whence the devil is ſtiled the adverſary, the tempter, and a murtherer from the beginning; that they are very falſe and crafty, whence the devil is called the *father of lies*, the *old ſerpent*; and his ſtratagems are ſtiled the *wiles, and depths of Satan*; that their malice is as active and reſtleſs, as it is great, whence we are told, 1 Pet. v. 8. that our adverſary the devil *walks about like a roaring lion, ſeeking whom he may devour.* Theſe things being taught us in the ſcripture itſelf, though I ſhall not now add any of the inferences, that may be drawn from them to my preſent purpoſe, we may rationally ſuppoſe, that if we were quick-ſighted enough to diſcern the methods of the divine wiſdom in the government of the angelical and of the diabolical worlds, or great communities, if I may ſo call them; we ſhould be raviſhed into admiration, how ſuch intelligent, free, powerful, and immortal agents, ſhould be, without violence offered to their nature, made in various manners to conſpire to fulfil the laws, or at leaſt accompliſh the ends, of that great theocracy, that does not alone reach to all kinds of bodies, to men, and to this or that rank of ſpirits, but compriſes the whole creation, or the great aggregate of all the creatures of God. And indeed to make the voluntary, and perhaps the moſt crafty actions of evil men, and of evil ſpirits themſelves, ſubſervient to his wiſe and juſt ends, does no leſs recommend the wiſdom of God, than it would the ſkill of a ſhipwright and pilot, if he was able to contrive and ſteer his ſhip ſo, as to ſail to his deſigned port, not only with a ſide-wind, or very near a wind, as many do; but with a quite contrary wind, and that a tempeſtuous one too.

24. Perhaps you will think it allowable, that on this occaſion I antedate, what in due time will infallibly come to paſs; and now briefly take ſome notice, as if it were preſent, of the diffuſed and illuſtrious manifeſtation of the divine wiſdom, (as well as juſtice and mercy,) that will glorioſly appear at the day of the general judgment, when every good Chriſtian's eyes ſhall be vouchſafed a much larger proſpect, than that, which his Saviour himſelf had, when he ſurveyed in a trice, and, as it were, at one view, *all the kingdoms of the world*; Luke iv. 5. and ſhall behold a much more numerous (not to ſay numberleſs) aſſembly, than that, which is ſaid to have conſiſted of Dan. iii. *all people, nations and languages*, that flocked in to the dedication of *Nebuchadnezzar*'s golden image.

At that great decretory day, when the whole off-ſpring of *Adam* ſhall, by the loud voice and trumpet of the arch-angel, be called together from the remoteſt ages and the diſtanteſt climates in the world; when, I ſay, beſides the fallen angels, all the human actors, that ever lived, ſhall appear upon the ſtage Rev. xx. 12. at once; *when the dead ſhall be raiſed, and the books ſhall be opened*, (that is, the records of heaven and of conſcience;) then the wiſdom of God will ſhine forth in its meridian luſtre, and its full ſplendor. Not only the occurrences, that relate to the lives and actions of particular perſons, or of private families, and other leſſer ſocieties of men, will be there found not to have been overlooked by the divine providence; but the fates of kingdoms and commonwealths, and the revolutions of nations and of empires, will appear to have been ordered and over-ruled by an incomparable wiſdom: and thoſe great politicians, that thought to out-wit providence by their refined ſubtilties, ſhall find themſelves taken in their own craftineſs, ſhall have their deepeſt counſels turned into fooliſhneſs, and ſhall not be able to keep the amazed world from diſcovering, that whilſt they thought they moſt craftily purſued their own ends, they really accompliſhed God's: and thoſe ſubtile hypocrites, that thought to make pretended religion the inſtrument of their ſecular deſigns, ſhall find thoſe deſigns both defeated, and made truly ſubſervient to that advancement of religion, which they really never aimed at.

25. To employ and keep in order a very complicated engine, ſuch as the famous *Straſburgh* clock, or a man of war, though all the parts of it be inanimate and devoid of purpoſes and ends of their own, is juſtly counted a piece of ſkill; and this taſk is more difficult, and conſequently does recommend the conduct of the performer, in proportion to the intricate ſtructure, and the number of pieces, whereof the engine conſiſts: at which rate, how aſtoniſhing and ravaging will appear that wiſdom and providence, that is able to guide and over-rule many thouſand millions of engines endowed with wills, ſo as to make them all be found, in the final iſſue of things, ſubſervient to purpoſes worthy of divine providence, holineſs, juſtice and goodneſs.

In ſhort, when all the actors, that had their parts in this world, ſhall appear at once upon the ſtage, when all diſguiſes ſhall be ſtript off, all intrigues diſcovered, all hearts and deſigns laid open; then to find, that this whole amazing opera, that has been acting upon the face of the earth, from the beginning to the end of time, has been ſo contrived and carried on by the great author of the world and of men, that their innumerably various actions, and croſs deſigns are brought, (commonly without, and often againſt their wills,) to conſpire to the accompliſhment of a plot worthy of God, will appear an effect of ſo vaſt and ſo all-pervading a wiſdom, as human intellects will admiringly confeſs, that nothing but a divine and omniſcient one could compaſs.

26. It is like you may have taken notice, that among the ſeveral inſtances I have given of the wiſdom of God, I have not, (unleſs perhaps incidentally and tranſiently,) mentioned the oeconomy of man's ſalvation by *Jeſus Chriſt*: and therefore I think myſelf obliged to advertiſe you, that though, for reaſons to be given you, if you deſire it, by word of mouth, I have thought fit that ſubject, which has been already handled by ſo many profeſſed divines, ſhould be left untreated of by me, who am a layman; yet I

did not pretermit it, upon the ſcore of thinking it at all inferior to thoſe other manifeſtations of God's wiſdom, that I expreſly diſcourſe of.

FOR I think, that in the redemption of mankind more of the divine attributes, than are commonly taken notice of, have their diſtinct agencies; and that their co-operation is ſo admirably directed by the divine wiſdom, that an apoſtle may very juſtly call it the *great myſtery of godlineſs*; and that it no leſs deſerves our wonder than our gratitude.

1 Tim. iii. 16.

27. I AM not ignorant, that many learned divines have largely, and ſome of them laudably treated of this ſubject. But I confeſs I doubt whether moſt of them have not been more happy in their care to avoid errors about it, than ſkilful in their attempts to unveil the myſteries couched in it. There are in the great work of man's redemption ſome characters and footſteps of the divine wiſdom, ſo conſpicuous, not to ſay ſo refulgent, that a believer endowed but with a mediocrity of parts may eaſily enough diſcern them; but there are alſo in this ſublime and comprehenſive work ſome *depths of God*, (to uſe a ſcripture phraſe) and ſo much of the *wiſdom of God in a myſtery*, (that is, of the myſterious wiſdom of God) that I cannot think it an eaſy matter to have a mental eye ſo enlightened and ſo piercing, as to treat largely and worthily of ſo vaſt and abſtruſe a ſubject. And indeed when I conſider, that a man muſt know much of the nature of ſpirits in general, and even of the father of them, God himſelf; of the intellect, will, *&c.* of the ſoul of man; of the ſtate of *Adam* in paradiſe, and after his fall; of the influence of his fall upon his poſterity, of the natural or arbitrary vindictive juſtice of God; of the grounds and ends of God's inflicting puniſhments, as a creditor, a ruler, or both; of the admirable and unparalled perſon of Chriſt the mediator; of thoſe qualifications and offices, that are required to fit him for being lapſed man's redeemer; of the nature of covenants, and the conditions of thoſe God vouchſafed to make with man, whether of works, or grace; of the divine decrees, in reference to man's final ſtate; of the ſecret and powerful operations of grace upon the mind, and the manner, by which the ſpirit of God works upon the ſouls of men, that he converts, and brings by ſanctification to glory: to be ſhort, there are ſo many points (for I have left divers unnamed) moſt of them of difficult ſpeculation, that are fit to be diſcuſſed by him, that would ſolidly and fully treat of the world's redemption by *Jeſus Chriſt*, that when I reflect on them, I am ready to exclaim with St. *Paul*, *who is ſufficient for theſe things?* and I am ſo far from wondering, that the generality of divines, and other writers on this ſubject, have not fully diſplayed the wiſdom, that God has expreſſed in this great work, that to have been able to accompliſh it in ſo admirable a way, as God has actually contrived and made choice of, is one of the chief reaſons of my admiration of the wiſdom itſelf. And I am perſuaded, that for God to reconcile his inflexible juſtice, his exuberant mercy, and all thoſe other things, that ſeemed to claſh inevitably about the deſigned ſalvation of men, and make them co-operate to it, is a ſtupendous manifeſtation of wiſdom; there being no problem in *Diophantus*, *Alexandrinus*, or *Apollonius Pergæus*, in algebra, or in geometry, near ſo difficult to be ſolved, or that requires, that a greater number of proportions and congruities ſhould be attended to at once, and made ſubſervient to the ſame ends, as that great problem propounded by God's infinite goodneſs to his divine wiſdom; *the redemption of loſt and perverſe mankind, upon the terms declared in the goſpel*, which are admirably fitted to promote at once God's glory and man's felicity.

Βάθη τȣ̃ Θεȣ̃. 1 Cor. ii. 10. II. 7.

28. THOUGH what has been ſaid of the greatneſs of God's power and wiſdom, may juſtly perſuade us, that thoſe attributes are divine and adorable; yet I muſt not deny, that the repreſentation, that I have made of them, is upon ſeveral accounts very diſadvantageous. For firſt, there has not been ſaid of them in this paper all, that even I could have mentioned, to ſet forth their excellency; becauſe I had elſewhere treated of that ſubject, and was more willing to preſent you with ſome things I had not ſaid before, than trouble you with many repetitions: but if, inſtead of ſo unfit a perſon as I, the manifeſtation of the divine wiſdom had been undertaken by the knowingeſt man in the world, or perhaps even by an angel, he would find himſelf unable fully to make out the matchleſs excellency of it. For how much wiſdom has been exerciſed by an omniſcient being, cannot be fully comprehended, or conſequently deſcribed, but by an infinite underſtanding: beſides, I have conſidered the wiſdom diſplayed by God in the works of his creation and providence, with reſpect to them not to us; for they are excellent, abſolutely, and in their own nature, and would ſimply upon that account deſerve the wonder and the praiſes of rational beings, as they are rational; as *Xeuxes* juſtly celebrated the ſkill of *Apelles*, and modern geometers and mechanitians admire *Archimedes*. But in this irrelative contemplation of God's works, a man's mind being intent only upon the excellencies he diſcovers in them, he is not near ſo much affected with a juſt ſenſe of the inferiority of his to the divine intellect, as he would be, if he heedfully conſider, how much of the vaſt ſubjects he contemplates are undiſcovered by him, and how dim and imperfect the knowledge is, which he has of that little he does diſcover. And now, laſtly, to the other diſadvantages, with which I have been reduced to repreſent (and ſo to blemiſh) the divine attributes, I muſt add, that I have inſiſted but upon two of them, God's power and his wiſdom; whereas we know, that he has divers other perfections, as (beſides thoſe incommunicable ones, his ſelf-experience, ſelf-ſufficiency, and independency) his goodneſs to all his creatures, his mercy to ſinful men, his juſtice, his veracity, *&c.*

And, as I long ſince noted, we may rationally conceive, that he may have divers attributes, and conſequently divers perfections, whereof we have at preſent no knowledge, or perhaps ſo much as particular conjecture; the inexhauſtible fecundity of the divine nature being ſuch, that, for aught we know, we are acquainted with but a ſmall part of the productions of an almighty power, accompanied with an infinite wiſdom, and excited to communicate itſelf by an exuberant goodneſs. And indeed I ſee not, why we may not ſay, that by the notion or idea we have of him, and by the help of ſome attributes we already know he has, we may in general conceive, that he has other perfections, that we yet know not in particular; ſince of thoſe attributes, that we do already know, though the irrelative ones (if I may ſo call them) ſuch as his ſelf-exiſtence, eternity, ſimplicity, and independency, may be known by mere ſpeculation, and, as it were, all at once, by appearing to us as comprehended in the notion of a being abſolutely perfect; yet there are divers relative attributes or perfections, that come to be known ſucceſſively, and as it were by experience of what he has actually done in relation to ſome of his creatures: as the mercy of God was not known by *Adam* himſelf before his fall; and God's fidelity or faithfulneſs to his promiſes, as particularly that of ſending the *Meſſias* in the fulneſs of time, was not, (not to ſay could not be) known but in proceſs of time, when ſome of them came to be fulfilled: and therefore, ſince ſome of God's perfections require or ſuppoſe the reſpective natures and conditions of his creatures, and the actings of ſome of them towards him, as well as ſome of his towards them; we, that cannot be at all ſure, that he may not have made many ſorts of creatures, and have had divers relations to them, according to their ſeveral ſtates and conditions, that we are altogether unacquainted with, cannot know, but that ſome of the attributes of God exerciſed towards theſe creatures may remain unknown to us.

29. But whether the attributes, known and unknown, be thought to be more or fewer, it will not be denied, but that the natural and genuine reſult of all theſe divine perfections, (which we conceive under diſtinct notions, becauſe we are not able to ſee them at one view, united in God's moſt ſimple eſſence) muſt be a moſt glorious majeſty, that requires the moſt lowly and proſtrate venerations of all the great creator's intelligent works: and accordingly we may obſerve (from ſome of the formerly cited texts) that the angels, who of all his mere creatures are the moſt excellent and knowing, are repreſented in the ſcripture as aſſiduouſly employing themſelves, not only in obeying and ſerving, but in praiſing and adoring the divine majeſty. The very name of angel in the original languages of the Old and New Teſtament, is a name of miniſtry, the Hebrew *Malach*, and the Greek Ἄγγελος, ſignifying properly a meſſenger. And our Saviour intimates in his moſt excellent pattern of prayer, that the will of God is done moſt obſequiouſly and chearfully in heaven; ſince Chriſtians are directed to wiſh, that their obedience there paid him might be imitated upon earth. And as they ſtile themſelves the apoſtles fellow-ſervants, ſo theſe celeſtial Rev. xix. envoys (if I may ſo call them) make no 10. ſcruple of going upon the meaneſt errands, as we would think them; conſidering rather by whom, than to whom, or about what, they are ſent. So the firſt angel, that we read of, to have been ſent to a particular perſon, was employed to *Hagar*, a wandering and Gen. xxi. fugitive female ſlave, ready to periſh for thirſt 17, &c. in a wilderneſs, to direct her to a well of water, and tell her ſomewhat, that concerned her child: and another angel is repreſented as taking the part of an aſs againſt a falſe Num. xxii. prophet; nay, of this glorious order of crea- 33. tures in general the ſcripture tells us, that *they are all miniſtring ſpirits, ſent forth to* Heb. i. 14. *miniſter for them, who ſhall be heirs of ſalvation.*

Though the angels are creatures ſo glorious in their apparitions here below, that they uſe to ſtrike amazement and veneration, if not terror, even into the excellent perſons Dan. x. 9, they appear to, (as we may learn from di- 11, 17. vers paſſages of the ſcripture, where we are Luke i. 29. told, that their preſence was accompanied with a ſurprizing ſplendor, and one of them is repreſented in the apocalypſe, as *inlightening the* Rev. xviii. *earth with his glory*; and though their mul- 1. titude be ſo great, that ſometimes the myriads of them, and ſometimes the legions, are mentioned, and elſewhere we are told of *thouſand thouſands, and ten thouſand times ten thouſand of them*: yet theſe celeſtial courtiers, that, in compariſon of us men, are ſo glorious, as well as intelligent and ſpotleſs, when they appear in multitudes about the throne of God, (according to that viſion of the prophet, who told the two Kings of *Judah* and *Iſrael*, that he ſaw the *Lord ſitting on his* 1 Kings *throne; and all the hoſts of heaven ſtanding by* xxii. 19. *him on his right hand and on his left*,) they Dan. vii. ſtand not to gaze, but, as the prophet *Daniel* 10. expreſsly ſays, to miniſter. And in *Iſaiah*'s Iſa. vi. 2. viſion, the ſeraphim themſelves are repreſented, as covering their faces before their great maker ſeated on his elevated throne. And we may eaſily gueſs, that their employment is moſt humbly to adore and celebrate ſuch dazzling majeſty, by what we are told of their crying one to another, *Holy, holy, holy, is the Lord of hoſts, the whole earth is full of his glory.* This profound reſpect of the angels is not to be marvelled at; ſince, where eſteem ſprings not from ignorance but knowledge, the greater the ability and opportunities are of having the knowledge clear and heightened, the greater veneration muſt be produced in an intelligent being for the admired object, whoſe perfections are ſuch, that even an angelical intellect cannot fully reach them; ſince, as a line, by being never ſo much extended in length, cannot grow a ſurface, ſo neither can created perfections

be by any ideas ſo ſtretched, as to be amplified into divine ones, (or ideas equal to them.) And indeed, ſpeaking in general, the creatures are but umbratile (if I may ſo ſpeak) and arbitrary pictures of the great creator; of divers of whoſe perfections though they have ſome ſignatures, yet they are but ſuch, as rather give the intellect riſes and occaſions to take notice of and contemplate the divine originals, than they afford true images of them: as a picture of a watch or man, or the name of either of them written with pen and ink, does not exhibite a true and perfect idea of a thing (whoſe internal conſtitution a ſurface cannot fully repreſent) but only gives occaſion to the mind to think of it, and to frame one. And what I have ſaid of the creatures in general, holds true of the angels themſelves, who by ſeveral prerogatives do indeed much ſurpaſs the reſt of their fellow creatures, but yet are but creatures, and therefore of a nature infinitely inferior to God's; as, though a thouſand is a far greater number than ten, and a million than a thouſand, yet the latter as well as the two former is beyond computation diſtant from a number ſuppoſed to be infinite; ſince otherwiſe a finite number (that by which the leſſer differs from the greater) would be able by its acceſſion to make a finite number become infinite. But to return to what I was ſaying of the angels: I thought fit to mention both the nobleneſs of their nature, the ſplendidneſs of their apparitions, and the profound veneration and ardent devotion, which they paid to their creator, becauſe we are wont to eſtimate remote things by compariſon; as modern philoſophers tell us, that we judge the riſing or ſetting ſun and moon to be greater and more diſtant from us, than when they are nearer the meridian; becauſe, when they are in the horizon, we conſider them as placed beyond mountains, or long tracts of land or ſea, that we know to be great objects, and look upon as remote ones, and yet ſee them interpoſed, and conſequently
Jud. ix. nearer than the celeſtial globes. For thus, ſince the ſcripture propoſes the angels to our imitation, the awful reverence paid to the ſupreme Being by thoſe excellent ſpirits, who,
2 Pet. xi. 11. as St. *Peter* tells us, *are greater in power and might than we*, ought to admoniſh us of the ecſtatic reſpect we mortals owe him, and teach us, that whenſoever we ſpeak either to God or of him, we ought to be inwardly affected (and in our outward expreſſions appear to be ſo) with the unmeaſurable diſtance there is between a moſt perfect and omnipotent creator, and a mere impotent creature, as well as between a moſt holy God, and a moſt ſinful man.

[30. If the conjectures formerly propoſed about worlds differing from ours may paſs for probable, then it will be ſo too, that God in theſe other ſyſtems may have framed a multitude of creatures, whoſe fabric and motions, and conſequently whoſe properties and operations, muſt be very differing from what is uſually met with in our world. And the various contrivances, wherein thoſe differences conſiſt, will be ſo many peculiar inſtances, as well as productions, of the *manifold wiſdom* of the great *former of all things*; or (as the ori- Jer. li. 19.
ginal expreſſion *yotſer hackol* will bear,) *Maker of the whole* (univerſe.) But to add ſomething now of nearer affinity to what was laſt ſaid about God's government of ſpirits, how much will this architectonic wiſdom (if I may ſo call it) exerted in framing and regulating an innumerable company of differing creatures, be recommended; if the other worlds or vortexes we not long ſince ſpoke of, and the inviſible part of ours, (as we may call the air and æther) be peopled with intelligent, though not viſible, inhabitants? For, though the ſcripture ſeems not to ſpeak expreſly of any more ſorts of ſpirits, than thoſe good ones, that retain the name of (the whole genus) angels, and the apoſtates, that are commonly called devils, becauſe theſe are the two ſorts of ſpirits, that it moſt concerns us men to be informed of; yet the ſcripture, that in the hiſtory of the creation does not clearly ſo much as mention the production of angels, and elſewhere repreſents them, as well the bad as the good, of very differing
orders, (as far as we can gueſs by the ſeveral Eph. vi.
names it gives them;) the ſcripture, I ſay, and xii.
does not deny, that there are any other ſorts of compared
ſpirits, than thoſe it expreſly takes notice of: with Col.
ſo that, without any affront to it, we may ad- i. and xvi.
mit there are ſuch, if any probable arguments of it be ſuggeſted to us, either by reaſon or experience. And it ſeems not very likely, that while our terraqueous globe, and our air, are frequented by multitudes of ſpirits, all the celeſtial globes, (very many of which do vaſtly exceed ours in bulk) and all the ætherial or fluid part of the world, (in compariſon of which, all the globes, the celeſtial and terreſtrial put together, are inconſiderable for bulk) ſhould be quite deſtitute of inhabitants. I have not time to ſet down the opinions of the antient as well Eaſtern as Grecian writers, eſpecially the Pythagoreans and Platoniſts, to whoſe maſter this ſentence is aſcribed concerning the multitudes of dæmons, (a name by them not confined to evil ſpirits) that lived in the ſuperior part of the world, Δαίμονες ἀήριοι γένος. I will not preſume to be poſitive in declaring the ſenſe of thoſe two expreſſions, which the ſcripture employs, where ſpeaking of the head of the ſatanical
kingdom, it calls him *the prince of the power* Eph. ii. 2.
of the air, (and the word air is, among the Hebrews taken in a great latitude, and ſeveral times uſed for the word heaven) and where ſpeaking of the grand adverſaries of the goſpel, it ſtyles the *ſpiritual wickedneſſes*, or rather (as the Syriac reads it, *ſpirits of wickedneſs*, that is) *wicked ſpirits*, not in high places, as our tranſlators have it, but in heavenly. But though, as I was ſaying, I will not be poſitive in giving theſe two texts ſuch a ſenſe, as may make them direct arguments for my conjecture; yet it ſeems, that if they do not require, at leaſt they may well bear, an interpretation ſuitable to my preſent purpoſe.

poſe. And whatever become of the aſſertions of heathen philoſophers and poets, it is very conſiderable what is noted by the excellent
Grotius on Eph. ii. 2. *Grotius*, (who quotes ſeveral Hebrew authors for it) that it was the opinion of the *Jews*, that all places from earth to heaven, even the ſtarry heaven, are full of ſpirits.
On Eph. vi. 12. If this be ſo, the wiſdom and power of God muſt reach much farther, than we are commonly aware of; ſince he has created, and does govern, ſuch an ineſtimable multitude of ſpiritual beings, of various kinds, each of them endowed with an intellect and will of its own; eſpecially ſince, for aught we know, many or moſt of them, and perhaps ſome whole orders of them, are yet in a probational ſtate, wherein they have free-will allowed them; as *Adam* and *Eve* were in *Eden*, and all the angels were, before ſome of them (as
Ep. Jud. 6. the ſcripture ſpeaks) *left their firſt* eſtate and their own manſion. And if to theſe angelical communities we add thoſe others of children, idiots, and mad-men; of whom, though all be in a ſenſe rational creatures, yet the firſt community have not attained the full uſe of reaſon, for want of age, and the two others cannot exerciſe that faculty, for want of rightly diſpoſed organs; the wiſdom and power of God in the divine government of ſuch various and numerous communities of intellectual creatures will, to a conſidering man, appear the more illuſtrious and wonderful.]

31. The diſtance betwixt the infinite creator and the creatures, which are but the limited and arbitrary productions of his power and will, is ſo vaſt, that all the divine attributes or perfections do by unmeaſurable intervals tranſcend thoſe faint reſemblances of them, that he has been pleaſed to impreſs, either upon other creatures, or upon us men. God's nature is ſo peculiar and excellent, that there are qualities, which, though high virtues in men, cannot belong to God, or be aſcribed to him without derogation; ſuch as are temperance, valour, humility, and divers others: which is the leſs to be wondered at, becauſe there are ſome virtues (as chaſtity, faith, patience, liberality) that belong to man himſelf, only in his mortal and infirm condition. But whatever excellencies there be, that are ſimply and abſolutely ſuch, and ſo may, without diſparagement to his matchleſs nature, be aſcribed to God, ſuch as are eternity, independency, life, underſtanding, will, &c. we may be ſure, that he poſſeſſes them; ſince he is the original author of all the degrees or reſemblances we men have of any of them. And the Pſalmiſt's ratiocination is good, *He*
Pſal. xciv. 9, 10. *that planted the ear, ſhall he not hear? He that formed the eye, ſhall not he ſee? He that teacheth man knowledge, ſhall not he know?* ſince all the perfections communicated to, or to be found in the creatures, (whether men, angels, or any other) being emanations of the divine excellencies, do as much belong to God, as in a bright day all the luminous beams, that are to be found in the air, belong to the ſun; (in whom they are united, and from whom they all proceeded.) The vaſt difference then between the perfections of the great creator, and thoſe, that are analogous to them in the creatures, reaches to all the perfections, that are, though in very differing manners, to be found in both; but yet the human underſtanding, as it values itſelf upon nothing more than wiſdom and knowledge, ſo there is nothing, that it eſteems and reverences more in other beings, and is leſs willing to acknowledge itſelf ſurpaſſed in: for which reaſon, as I have in the foregoing part of this paper inculcated by more than one way, the great ſuperiority of God's intellect to man's; ſo I think it not improper to proſecute the ſame deſign, by mentioning to you ſome few particulars, whereby that ſuperiority may manifeſtly appear. We may then conſider, that beſides God knows an innumerable company of things, that we are altogether unacquainted with, ſince he cannot but know all the creatures he has made, whether viſible or inviſible, corporeal or immaterial, and what he has enabled them to do, according to that of St. *James, Known unto God are all his works from the beginning of the world*; nay, ſince he Acts xv. 18.
cannot but know the extent of his own infinite power, he cannot but know numberleſs things, as poſſible, that he has not yet made, nor perhaps ever will pleaſe to make. But to confine myſelf to things actually exiſtent, beſides his corporeal and immaterial creatures, and their faculties or powers, whereof we have ſome kind of notice, and beſides perhaps multitudes of other things, whereof we have no particular idea or conjecture; he knows thoſe things whereof we men have alſo ſome knowledge, in a manner or degree peculiar to himſelf: as what we know but in part, he knows clearly, and what we know but by fallible mediums, he knows moſt certainly.

32. But the great prerogative of God's knowledge is, that he perfectly knows himſelf; that knowledge being not only too wonderful for a man (as even an inſpired perſon confeſſes touching himſelf) but beyond the reach of an angelical intellect; ſince fully to comprehend the infinite nature of God, no leſs than an infinite underſtanding is requiſite. And for the works of God, even thoſe, that are purely corporeal, (which are therefore the meaneſt) our knowledge of theſe is incomparably inferior to his: for though ſome modern philoſophers have made ingenious attempts to explain the nature of things corporeal, yet their explications generally ſuppoſe the preſent fabric of the world, and the laws of motion that are ſettled in it; but God knows particularly, both why and how the univerſal matter was firſt contrived into this admirable univerſe, rather than a world of any other of the numberleſs conſtructions he could have given it; and both why thoſe laws of motion, rather than others, were eſtabliſhed; and how ſenſeleſs matter, to whoſe nature motion does not at all belong, comes to be both put into motion, and qualified to transfer it according to determinate rules,

which itſelf cannot underſtand. But when we come to conſider the particular and more elaborate works of nature; ſuch as the ſeeds or eggs of living creatures, or the texture of quickſilver, poiſons, antidotes, *&c.* the ingenious confeſs their ignorance, (about the manner of their production and operations) and the confident betray theirs. But it is like we men know ourſelves better, than what is without us; but how ignorant we are at home, if the endleſs diſputes of *Ariſtotle* and his commentators and other philoſophers about the human ſoul, and of phyſicians and anatomiſts about the mechaniſm and theory of the human body, were not ſufficient to manifeſt it, it were eaſy to be ſhewn (as it is in another paper) by the very conditions of the union of the ſoul and body; which being ſettled at firſt by God's arbitrary inſtitution, and having nothing in all nature parallel to them, the manner and terms of that ſtrange union is a riddle to philoſophers, but muſt needs be clearly known to him, that alone did inſtitute it, and, (all the while it laſts) does preſerve it. And there are ſeveral advantages of the divine knowledge above that of man, that are not here to be pretermitted; for firſt, we men can perceive and ſufficiently attend but to few things at once; according to the known ſaying,

The Title of this Paper is, *The Imperfection of Human knowledge manifeſted by its own light.*

Pluribus intentus minor eſt ad ſingula ſenſus.

AND it is recorded as a wonder of ſome great men among the ancients, that they could dictate to two or three ſecretaries at once. But God's knowledge reaches at once to all, that he can know; his penetrating eyes pierce quite thorough the whole creation at one look; and, as an inſpired penman declares, *there is no creature, that is not manifeſt in his ſight, but all things are naked*, and (if I may ſo render the greek word) *extraverted to his eyes.* He always ſees incomparably more objects at one view, than the ſun himſelf endued with ſight could do; for God beholds at once all, that every one of his creatures, (whether viſible or inviſible to us) in the vaſt univerſe, either does or thinks. Next, the knowlenge of God is not a progreſſive or diſcurſive thing, like that acquired by our ratiocinations, but an intuitive knowledge; ſince, though we men, by reaſon of the limitedneſs and imperfections of our underſtandings, are fain to make the notice we have of one thing a ſtep and help to acquire that of another, which to us is leſs known; as may eaſily be obſerved even in the forms of ſyllogiſms; yet God, whoſe knowledge as well as his other attributes are infinitely perfect, needs not know any one thing by the help of another; but knows every thing in itſelf (as being the author of it;) and all things being equally known to him, he can, by looking, if I may ſo ſpeak, into himſelf, ſee there, as in a divine and univerſal looking-glaſs, every thing, that is knowable, moſt diſtinctly, and yet all at once. *Thirdly*, God knows men's moſt ſecret thoughts and intentions: whence he is called Καρδιαγνώστης, and the *ſearcher of all hearts, that underſtandeth all the imaginations of the thoughts.* Nay he knows men's thoughts afar off, and even never vented thoughts, which the man himſelf may not know: for not only St. *John* ſays, *that if our heart condemns us, God is greater than our heart, and knows all things*; but God enabled *Daniel* to declare to *Nebuchadnezzar* the whole ſeries of the prophetick dream, whereof that monarch's own memory could not retrieve any part. And here give me leave to obſerve, (what perchance you have not minded) that even of a thing, that happens to a man's ſelf, and is of a nature capable to make the moſt vived impreſſions on him, God's knowledge may ſurpaſs his; ſince St. *Paul* ſpeaking of his being caught up into paradiſe, after having twice ſaid, *whether in the body I canuot tell, or whether out of the body, I cannot tell*, he both times ſubjoins, that *God knows.* Our knowledge of ourſelves, as well as that of thoſe other creatures, that are without us, being ſo defective, the confidence of ſome, that dare pretend to know God fully by the light of their natural reaſon, will not hinder me from taking hence a riſe to aſk this ſhort queſtion; *How imperfect muſt mere philoſophers knowledge of God's nature be, ſince they know him but by his works, and know his works themſelves but very imperfectly?* The other and fourth conſpicuous prerogative of the divine knowledge is the preſcience of future contingents, that depend upon the determinations and actions of free agents: for we men are ſo far from being able to ſtretch our knowledge to the diſcovery of that ſort of events, that the greateſt clerks have try'd their wits in vain to diſcover, how God himſelf can foreknow them; and therefore too many, even among Chriſtians, deny, that he can, though by divers accompliſhed predictions recorded in ſcripture it manifeſtly appears, that he does.

Heb. iv. 13.
τετραχηλισμένα.

1 Chron. xxviii. 9.
Pſalms cxxxix. 2.
1 Joh. iii. 20.
Dan. ii. 5. 31.
2 Cor. xii. 2, 3, 4.

33. WHEN I conſider the tranſcendant excellency, and the numerous prerogatives of the Deity, I cannot without wonder, as well as trouble, obſerve, that rational men profeſſing Chriſtianity, and many of them ſtudious too, ſhould wilfully, and perhaps contemptuouſly, neglect to acquire or reflect on thoſe notices, that are apt to increaſe their knowledge of God, and conſequently their veneration for him. To aſpire to a farther knowledge of God, that we may the better adore him, is a great part both of man's duty and his happineſs. God, who has put into men an innate deſire of knowledge, and a faculty to diſtinguiſh the degrees of excellency in differing notices, and to reliſh thoſe moſt, that beſt deſerve it, and has made it his duty to ſearch and inquire after God, and to love him above all things, would not have done this, if he had not known, that thoſe, that make a right uſe of their faculties, muſt find him to be the nobleſt object of the underſtanding, and that, which moſt merits their wonder and veneration. And, indeed, what can

be more ſuitable to a rational creature, than to employ reaſon to contemplate that divine being, which is both the author of its reaſon, and the nobleſt object, about which it can poſſibly be employed? The knowledge of ſome dead language, or ſome old ruſty medal, or the opinions and cuſtoms of ſome nations or ſects, that did not perhaps reaſon nor live any better, than we do now, are thought worthy of curioſity, and even of the laborious induſtry of learned men; and the ſtudy of things merely corporeal gains men the honourable title of philoſophers. But whatever theſe objects of inquiry be in themſelves, it is certain the greateſt diſcoveries we can make of them are but trifles, in compariſon of the excellency of the knowledge of God, which does as much ſurpaſs that of his works, as he himſelf does them. And it is the prerogative of his nature, to be infinitely above all that he has made; whether we contemplate the works of nature, or thoſe of art, whereof the former are, under another name, his more immediate works; and the others the effects of one of his works; and by conſequence are originally his, though produced by the intervention of man. And though it be moſt true, that on the corporeal world God has been pleaſed to ſtamp ſuch impreſſes of his power, wiſdom and goodneſs, as have juſtly exacted the admiration even of philoſophers, yet the great author of the world is himſelf incomparably ſuperior to all his workmanſhip, inſomuch, that though he could have made, and always will be able to make, creatures more perfect, than thoſe he has made, by incomputable degrees of perfection; yet the prerogative of his nature will keep him neceſſarily ſuperior to the excellenteſt creatures he can make, ſince the very condition of a creature hinders it from being (to name now no other of the divine attributes) ſelf exiſtent and independent. It is therefore methinks a ſad thing, that we men ſhould grudge to ſpend now and then a few hours in the contemplation and internal worſhip of that moſt glorious and perfect being, that continually employs the devotion of Angels themſelves. This I judge probable from hence, that thoſe bleſſed ſpirits are repreſented in the ſcripture, as celebrating with joyfull ſongs and acclamations the nativity of the world; and I think they may well be ſuppoſed to have an ardent deſire to obtain a farther knowledge of God himſelf; ſince, as an Apoſtle aſſures us, they earneſtly deſire to look into the truths contained in the goſpel, and the diſpenſations of God towards frail and mortal men.

34. I KNOW I may be told, that *ſcrutator majeſtatis, &c.* and that it is a dangerous thing to be inquiſitive about the nature of God: but not to urge, that the Latin ſentence is taken but out of an apocryphal book, I anſwer, that the ſecret things of God, that are to be left to himſelf, ſeem to be his unrevealed purpoſes and decrees, and his moſt abſtruſe eſſence or ſubſtance, the ſcrutiny whereof I readily acknowledge not to belong to us; but I think there is a great difference between contemplating God out of a ſaucy curioſity, merely to know ſomewhat, that is not common of him, and doing it out of an humble deſire, by a farther knowledge of him, to heighten our reverence and devotion towards him. It is an effect of arrogance to endeavour, or ſo much as hope, to comprehend the divine perfections ſo, as to leave nothing in them unknown to the inquirer: but to aſpire to know them farther and farther, that they may proportionably appear more and more admirable and lovely in our eyes, is not only an excuſable, but a laudable curioſity. The ſcripture in one place exhorts us *to grow* not only *in grace*, but *in the knowledge of Chriſt*; and in another, *to add to our virtue knowledge*; and when *Moſes* begged to be bleſſed with a nearer and more particular view of God, though part of his requeſt was refuſed, becauſe the grant of it was unſuitable to his mortal ſtate, and perhaps muſt have proved fatal to him, whilſt he was in it; yet God vouchſafed ſo gracious a return to his petition, as ſhews he was not diſpleaſed with the ſupplicant; no action or ſuffering of his having procured for him ſo glorious a view, as was then vouchſafed to his holy curioſity. And that we may aſpire to great degrees of knowledge, even at thoſe ſupernatural objects, that we cannot adequately know, we may learn from St. *Paul*, who prays, that his *Epheſians*, as all true Chriſtians, may be able to comprehend what is the breadth and length and depth and height, and to know the love of Chriſt, which, ſays he in the very next words, paſſeth knowledge. Suppoſing it then lawfull to contemplate God, not with deſign to pry into his decrees and purpoſes, nor to dogmatize in points controverted among the learned about his nature and attributes, but to excite in ourſelves the ſentiments, which his indiſputable perfections are by a more attentive view qualified to produce; I conſider, that the devout contemplation of God, beſides other great advantages, that it brings the mind, inſomuch that the human underſtanding, like *Moſes* in the mount, does by an aſſiduous converſe with God acquire a laſting luminouſneſs; beſides this, I ſay, and the improving influence, that this happy converſation may have upon the graces and virtues of the mind, I take it to be one of the moſt delightful exerciſes, that the ſoul is capable of on this ſide Heaven. It is generally acknowledged, that admiration is one of the moſt pleaſing affections of the mind, which ſometimes, when the object deſerves it, is ſo poſſeſt thereby, as to forget all other things, or leave them unregarded; as it often happens in maſks, and other pompous and ſurprizing ſhews or ſpectacles; and as, upon a better ground, it happened to St. *Peter*, when being raviſhed with the glorious transfiguration of his and our maſter upon mount *Tabor*, he exclaimed, that it was good for them to be there, and talked of building

2 Pet. iii. 18.

2 Pet. i. 5.

Exodus xxxiii. 18.

Exodus xxxiv. 5, 6, *&c.*

Eph. iii. 18.

Exodus xxxiv. 29, 30, *&c.*

building tabernacles for thoſe, that had heavenly manſions, being ſo tranſported with the raviſhing ſight, that the evangeliſt expreſly notes, that *he knew not what he ſaid.* Ln. ix. 23. Now, the pleaſure, that admiration gives, being uſually proportionate to the uncommon nature and indearing circumſtances of the thing admired, how can any admiration afford ſuch a contentment, as that, which has God himſelf for its object, and in him the moſt ſingular and the moſt excellent of all Beings? The wonder produced in us by an humble and attentive contemplation of God has two main advantages, above the admiration we have for any of his works, or of our own. For firſt, when we admire corporeal things, how noble and precious ſoever they be, as ſtars and gems, the contentment, that accompanies our wonder, is allayed by a kind of ſecret reproach grounded on that very wonder; ſince it argues a great imperfection in our underſtandings, to be poſed by things, that are but creatures, as well as we, and, which is worſe, of a nature very much inferior to ours: whereas it is no diſparagement at all for a human, and conſequently a finite intellect, to be poſſeſſed with wonder, though it were heightened to amazement or aſtoniſhment, by the contemplation of that moſt glorious and infinitely perfect Being, which muſt neceſſarily exceed the adequate comprehenſion of any created intellect. But I conſider, that there is a farther and much greater (which is the ſecond) advantage of the admiration of God above that of other things; for other objects having but a bounded nature, and commonly but ſome one thing fit to be wondered at, our admiration of them is ſeldom laſting, but, after a little familiarity with them, firſt languiſhes and then ceaſes: but God is an object, whoſe nature is ſo very ſingular, and whoſe perfections are ſo immenſe, that no aſſiduity of conſidering him can make him ceaſe to be admirable, but the more knowledge we obtain of him, the more reaſon we find to admire him; ſo that there may be a perpetual viciſſitude of our happy acqueſts of farther degrees of knowledge, and our eager deſires of new ones. Becauſe we give him but one name, we are apt to look upon him, as but one object of ſpeculation; but though God be indeed but one in eſſence or nature, yet ſuch is his immenſity, and, if I may ſo ſpeak, fecundity, that he is unſpeakably various in the capacity of an object. Thus heaven goes under one name, but contains ſo many fixed ſtars and planets, and they, by their diverſity of motions, exhibit ſo many phænomena, that though they have employed the curioſity of aſtronomers for many ages, yet our times have, in the celeſtial part of the world, made diſcoveries as conſiderable, if not as numerous, as all thoſe of the antients; and as our optick glaſſes have detected many fixed ſtars, and divers planets, that were unknown to former times, ſo our navigators, by their voyages beyond the line, have diſcovered divers whole conſtellations in the ſouthern hemiſphere: ſo that though heaven be an object, that has been perpetually and conſpicuouſly expoſed to men's view and curioſity for ſome thouſands of years, yet it ſtill affords new ſubjects for their wonder; and I ſcarce doubt, but by the farther improvements of teleſcopes poſterity will have its curioſity gratified by the diſcovery both of new conſtellations, and of new ſtars in thoſe, that are known to us already. We need not therefore fear our admiration of God ſhould expire, for want of objects fit to keep it up. That boundleſs ocean contains a variety of excellent objects, that is as little to be exhauſted, as the creatures, that live in our ſublunary ocean, or lie on the ſhores, that limit it, can be numbered. To the wonderful excellency of God may be juſtly applied that notion, which *Ariſtotle* lays down as a kind of definition of infinite; namely, that it is that, of which how much ſoever one takes, there ſtill remains more to be taken. If the intellect ſhould for ever make a farther and farther progreſs in the knowledge of the wonders of the divine nature, attributes and diſpenſations; yet it may ſtill make diſcoveries of freſh things worthy to be admired: as in an infinite ſeries, or row of aſcending numbers, though you may ſtill advance to greater and greater numbers, yet all that you can do by that progreſs, is to go farther and farther from the firſt and leaſt term of the progreſſion, (which in our caſe anſwers to the ſmalleſt degree of our knowledge of God) without ever reaching, or, which may ſeem ſtrange, but is true, ſo much as approaching to an infinite number, (in caſe there were any ſuch) or even to the greateſt of all numbers; as will be acknowledged by thoſe, that have looked into the properties of progreſſions *in infinitum.*

35. The two advantages I come from mentioning, which the admiration of God has, in point of delightfulneſs, joined to the other advantages of our contemplation of him, have, I hope, perſuaded you, that they are very much wanting to themſelves, as well as to the duty they owe their Maker, that refuſe or neglect to give their thoughts ſo pleaſing, as well as noble an employment. And I am apt to think, upon this account in particular, that reaſon is a greater bleſſing to other men, than to atheiſts, who, whilſt they are ſuch, cannot employ it about God, but with diſbelief or terror; and that on this very ſcore *Epicurus* was far leſs happy than *Plato*; ſince whereas the latter was oftentimes, as it were, ſwallowed up in contemplation of the Deity, the former had no ſuch glorious object to poſſeſs him with an equally rational and delighful admiration.

36. But now, (to apply this to the ſcope of this whole diſcourſe) though ſo pure and ſpiritual a pleaſure is a very allowable attractive to elevate our thoughts to the moſt glorious and amiable of objects; yet it ought to be both the deſign and the effect of our admiration of God, to produce in us leſs unworthy ideas, and more honourable

and reverent thoughts of that wonderful and unparalleled Being; of whom the more we diſcover, the more we diſcern him to be ſuperior to all his works, and particularly to ourſelves, who are not of the higheſt order of them, and who, as mere men, are ſcarce in any thing more noble, than in the capacity and permiſſion of knowing, admiring and adoring God; which he that thinks a mean and melancholy employment, might be to ſeek for happineſs in heaven itſelf, if ſo unqualified a ſoul could be admitted there. The genuine effect of a nearer or more attentive view of infinite excellency is a deep ſenſe of our own great inferiority to it, and of the great veneration and fear we owe (to ſpeak in a ſcripture phraſe) to this glorious and Deut. xxviii. 58. fearful name, (that is, object) *The Lord our God.* And accordingly, when God had ſpoken to *Job* out of the whirlwind, and declared ſomewhat to him of the divine greatneſs, this holy philoſopher much alters his ſtyle, and confeſſes, that in his former diſ- Job xlii. 3, 4, 5, 6. courſes of God, he had *uttered what he underſtood not, things too wonderful for him, which he knew not*: and having thereupon implored inſtruction from God, he declares how fit a nearer knowledge of him is to make a man have low thoughts of *himſelf*; *I have heard of thee,* (ſays he to his Maker) *by the hearing of the ear; but now mine eye ſeeth thee: wherefore* (infers he) *I abhor myſelf, and repent in duſt and aſhes.*

I KNOW you may look upon a good part of this excurſion as a digreſſion; but if it be, it will quickly be forgiven, if you will pardon me for it, as eaſily as I can pardon myſelf for finding myſelf in *David*'s caſe, when he ſaid, *my heart was hot within me, while I* Pſalm xxxix. 3. *was muſing the fire burned,* as he ſaid, *then ſpake I with my tongue*: ſo I was content to let my pen run on in ſo pleaſant and noble a theme, and endeavour to excite, at leaſt in myſelf, ſuch a well grounded admiration of Rom. xii. 2. God, as may perhaps be a part of my *reaſonable ſervice* to him, or rational worſhip of Pſal. l. 23. him. God is pleaſed to declare, *that he that offers* (or, as it is in the original, ſacrifices) *praiſe, glorifies him*; and the ſcripture expreſly ſtyles our devotion *ſacrifices of praiſe.* Heb. xiii. 15. And we may well ſuppoſe, that if the *calves of our lips,* as our celebrations of God are ſomewhere called, are encouraged by God, thoſe mental offerings, that conſiſt in high and honourable thoughts of him, and in lowly humble ſentiments of ourſelves, in the view of his excellency, will not be leſs ac- Heb. xii. 28. ceptable to him; ſuch *reverence and devout fear* (to ſpeak with the inſpired writer to the John iv. 23. Hebrews) being indeed a kind of *adoring God in ſpirit and in truth*; and he that is ſo employed, may, with contentment, compare his condition to that of *Zacharias,* when it Luke i. 9. was ſaid of him, that *his lot was to burn incenſe,* to offer up to God the nobleſt and pureſt ſort of the legal ſacrifices. But, that I may not too far digreſs, I ſhall only add, that I think myſelf very worthily, as well as delightfully employed, when I am ſeeking after, and bringing together, what helps I can, to greaten, as much as I am able, thoſe ſentiments of wonder and veneration for God, that I am ſure can never be great enough; eſpecially ſince the more we know and adore that infinite excellency and exuberant fountain of goodneſs, the more influence and advantages we derive from it: agreeably to which, God is introduced in the ſcripture, ſaying of one of his adorers, to whom, in the ſame pſalm, many other bleſſings are alſo promiſed, *be-* Pſal. xci. 14, 15, 16. *cauſe he has ſet his love upon me, therefore will I deliver him: I will ſet him on high, becauſe he has known my name.*

WE have generally, through incogitancy, or vice, or prejudices, or the majeſty and abſtruſeneſs of the ſubject, ſo great an indiſpoſition to excite and cheriſh in ourſelves an awful veneration for God, and a ſtudious contemplation of his adorable attributes, that it ſeemed no more than needful to employ variety of arguments, drawn from different topicks, to engage our own and other men's minds, and repeated inculcations to preſs them to an exerciſe, which they neither are, nor are willing to be acquainted with. This conſideration will, I hope, be my apology, if, in the preſent tract, I lay hold on ſeveral occaſions, and make uſe of diverſities of diſcourſe, to recommend a duty, that does very much both merit, and need to be not only propoſed but inculcated; and yet I will not any farther lengthen this foregoing excurſion, (as I hope you will think it, rather than a mere digreſſion,) nor any longer forget, that when I begun it, I was diſcourſing of the great caution and profound reſpect, with which we ought to ſpeak of God.

37. IT were tedious to inſiſt on all the arguments, that may be brought of the immenſe inferiority of man's intellect to God's; and therefore I ſhall here content myſelf to illuſtrate ſome part of it, by a ſimile borrowed from the ſuperior and inferior luminaries of heaven; human reaſon, in compariſon of the divine intellect, being but like the moon in reference to the ſun. For as the moon, at beſt, is but a ſmall ſtar in compariſon of the ſun, and has but a dim light, and that too but borrowed; and has her wane, as well as her full, and is often ſubject to eclipſes, and always blemiſhed with dark ſpots: ſo the light of human reaſon is but very ſmall and dim, in compariſon of his knowledge, that is truly called in ſcripture the *Fountain,* as the *Father,* of light; and Pſalm xxxvi. 9. this light itſelf, which ſhines in the human intellect, is derived from the irradiation it re- Jam. i. 17. ceives from God, *in whoſe light* it is, that *we ſee light.* Pſalm. xxxvi. 9. And this, as it is but a communicated light, is ſubject to be encreaſed, impaired, and oftentimes to be almoſt totally eclipſed, either by the darkening fumes of luſts or paſſions, or the ſuſpenſion of the provoked donor's beams, and, in its beſt ſtate, is always blemiſhed with imperfections, that make it uncapable of an entire and uniform illumination.

UPON theſe and divers other conſiderations I, for my part, think it becomes us men to uſe an awful circumſpection, not only when we make philoſophical inquiries or ſcholaſtic diſputes about God, that is, when we preſume to diſcourſe of him; but when we ſolemnly deſign to praiſe him; for it is one thing to ſay true things of God, and another to ſay things worthy of God. Our ideas of him may be the beſt we are able to frame, and yet may far better expreſs the greatneſs of our veneration for him, than the immenſity of his perfections; and even thoſe notions of them, that may be worthy of the moſt intelligent of men, will fall extremely ſhort of being worthy of the incomprehenſible God. The brighteſt and leaſt unlike idea we can frame of God, is infinitely more inferior in reference to him, than a parhelion is in reference to the ſun: for, though that meteor appear a ſplendid and ſublime thing, and have ſo much reſemblance to the ſun (without whoſe own beams it is not produced) as to be readily perceived to be his image, excluſively to that of any other: yet reſiding in a cloud, whoſe ſtation is near the earth, it is by an immenſe diſtance beneath the ſun, and is no leſs inferior to him in bigneſs and in ſplendor, as well as in many other attributes. He has, in my opinion, the trueſt veneration for God, not who can ſet forth his excellencies and prerogatives in the moſt high and pompous expreſſions; but he, who willingly has a deep and real ſenſe of the unmeaſurable inferiority of himſelf, and his beſt ideas, to the unbounded and unparalleled perfections of his Maker. And here indignation prompts me to this reflection, that if [ſince] even our hymns and praiſes of God, the ſupreme Being, deſerve our bluſhes, and need his pardon, what confuſion will one day cover the faces of thoſe, that do not only ſpeak ſlightly and careleſly, but often times contemptuouſly, and perhaps drollingly, of that ſupreme and infinitely perfect Being, to whom they owe thoſe very faculties, and that wit, which they ſo ungratefully, as well as impiouſly miſemploy? And indeed, ſuch tranſcendent excellencies, as the divine ones muſt be, might juſtly diſcourage us from offering ſo much as to celebrate them, if infinite goodneſs were not one of them. I ſhall not therefore allow myſelf the preſumption of pretending to make, as it were, a panegyric of God, of whom it is very eaſy to ſpeak too much, though it be not poſſible to ſay enough; contenting myſelf with an humble adoration of perfections, whereof my utmoſt praiſes would rather expreſs my own weakneſs than their excellency; ſince of this ineffable object, the higheſt things, that can be expreſſed in words, muſt therefore fall ſhort, becauſe words cannot expreſs them: which aſſertion, though it be a paradox, yet I think it is not truly an hyperbole; for we are not able to determine and reach, ſo much as in our thoughts, the greateſt of all poſſible numbers; ſince we may conceive, that any one (whatſoever it be) that can be pitched upon or aſſigned, may be doubled, trebled, or multiplied by ſome other number, or may be but the root of a ſquare or cubical number. By which inſtance (that perhaps you have not met with) you may perceive, that any determinate conception, that we can have (for example) of God's immenſity (to ſpecify now no other of his attributes) muſt therefore be ſhort of it, becauſe it is a determined or bounded conception. It is fit therefore, that I ſhould at length put limits to my diſcourſe, ſince none can be put to the extent or perfections of my ſubject.

The CONCLUSION.

THE reſult of what hath been ſaid in the paſt excurſion, will, I hope, amount to a ſufficient juſtification of what hath been ſaid at the beginning of this diſcourſe about *The high veneration our intellects owe to God.* For ſince we may well think in general, that he hath divers attributes and perfections, of which we have no knowledge or ſuſpicion in particular; and ſince of thoſe attributes of his, that are the moſt manifeſt to us, as his power and wiſdom, we have but a very dim and narrow knowledge, and may clearly perceive, that there is in theſe an unbounded extent of perfection, beyond all that we can evidently and diſtinctly diſcern of them; how unfit muſt ſuch imperfect creatures, as we are, be to talk haſtily and confidently of God, as of an object, that our contracted underſtandings graſp, as they are able (or pretend to be ſo) to do other objects! And how deep a ſenſe ought we to have of our ineſtimable inferiority to a Being, in reference to whom, both our ignorance and our knowledge ought to be the parents of devotion! ſince our neceſſary ignorance proceeds from the numerouſneſs and incomprehenſibleneſs of his (many of them undiſcovered) excellencies, and our knowledge qualifies us but to be the more intelligent admirers of his conſpicuous perfections.

IF we duly and impartially conſider theſe and the like things, we may clearly perceive, how great an effect and mark of ignorance, as well as preſumption, it is, for us mortals, to talk of God's nature and the extent of his knowledge, as of things, that we are able to look through, and to meaſure. Whereas we ought, whenever we ſpeak of God and of his attributes, to ſtand in great awe, leſt we be guilty of any miſapprehenſion or miſrepreſentation of him, that we might, by any warineſs and humility of ours, have avoided; and leſt, by an over-weening opinion of ourſelves, we preſume, that we have a perfect, or, at leaſt, a ſufficient knowledge of every thing in God, whereof we have ſome knowledge; ſince this, at the leaſt, conſiſts in ſuch notions, as are rather ſuited to our limited faculties, than any way equal to his boundleſs perfections.

THAT high order of intellectual beings the angels, though their minds be ſo illuminated, and their knowledge ſo extenſive; the angels themſelves, I ſay, are in the ſcripture affirmed to be deſirous to pry into the myſteries of the goſpel: whence we may gueſs, how far they are from penetrating to the bottom of what the ſcripture calls *the depths of God*; and how much farther they are from comprehending the infinite nature of God. And accordingly, when in the (formerly mentioned) majeſtic viſion, that appeared to the prophet *Iſaiah*, they are ſet forth as attendants about the throne of God, they are repreſented *covering their faces with their wings*, as not able to ſupport, or not preſuming to gaze on the dazling brightneſs of the divine majeſty. And ſhall we, poor ſinful mortals, who are infinitely beneath him, not only by the degeneracy and ſinfulneſs of our lives, but even by the imperfection and inferiority of our nature, preſume to talk forwardly or irreverently of the divine eſſence and perfections, without conſidering the immenſe diſtance betwixt God and us: and how unable, as well as unworthy, we are to penetrate the receſſes of that inſcrutable, as well as adorable nature; and how much better it would become us, when we ſpeak of objects ſo much above us, to imitate the juſt humility of that inſpired poet, that ſaid * *Such knowlege is too wonderful for me; it is high, I cannot attain unto it*; and join in that ſeemingly, and yet but ſeemingly, lofty celebration of God, † *That his glorious name is exalted above all bleſſing and praiſe.*

* Pſalm cxxxvi. 6.

† Neh. ix. 5.

A
FREE INQUIRY
Into the VULGARLY RECEIVED
NOTION of NATURE:
Made in an
ESSAY,
Addreſſed to a FRIEND.

Audendum eſt, et veritas inveſtiganda; quam etiamſi non aſſequamur, omnino tamen proprius, quam nunc ſumus, ad eam perveniemus. GALENUS.

The PREFACE.

I HAVE often wondered, that, in ſo inquiſitive an age as this, among thoſe many learned men, that have with much freedom, as well as acuteneſs, written of the works of nature, (as they call them) and ſome of them of the principles too, I have not met with any, that has made it his buſineſs to write of nature herſelf. This will perhaps hereafter be thought ſuch an omiſſion, as if, giving an account of the political eſtate of a kingdom, one ſhould treat largely of the civil judges, military officers, and other ſubordinate magiſtrates, and of the particular ranks and orders of inferior ſubjects and plebeians, but ſhould be ſilent of the prerogatives and ways of adminiſtration of the king; or, (to uſe a compariſon more ſuitable to the ſubject) as if one ſhould particularly treat of the barrel, wheels, ſtring, ballance, index, and other parts of a watch, without examining the nature of the ſpring, that ſets all theſe a moving. When I ſay this, I do not forget, that the word nature is every where to be met with in the writings of phyſiologers: but, though they frequently employ the word, they ſeem not to have much conſidered what notion ought to be framed of the thing, which they ſuppoſe and admire, and, upon occaſion, celebrate, but do not call in queſtion or diſcuſs. Weighing therefore with myſelf, of what great moment the framing a right or a wrong idea of nature muſt be, in reference both to the ſpeculative and practical part of phyſiology, I judged it very well worth the while, to make, with philoſophical freedom, a ſerious inquiry into the vulgarly received notion of nature; that, if it appeared well grounded, I might have the rational ſatisfaction of not having acquieſced in it, till after a previous examen; if I ſhould find it confuſed and ambiguous, I might endeavour to remedy that inconvenience, by diſtinguiſhing the acceptions of the word; if I found it dubious as to its truth, I might be ſhy in truſting too much to a diſtruſted principle; and, if I found it erroneous, I might avoid the raiſing ſuperſtructures of my own, or relying on thoſe of others, that muſt owe their ſtability to an unſound and deceitful foundation. And, becauſe many atheiſts aſcribe ſo much to nature, that they think it needleſs to have recourſe to a deity for the giving an account of the phænomena of the univerſe; and, on the other ſide, very many theiſts ſeem to think the commonly received notion of nature little leſs than neceſſary to the proof of the exiſtence and providence of God: I, who differ from both theſe parties, and yet think every true theiſt, and much more every true Chriſtian, ought to be much concerned for truths, that have ſo powerful an influence on religion, thought myſelf, for it's ſake, obliged to conſider this matter, both with the more attention and with regard to religion.

And yet being to write this treatiſe as a Phyſiologer, not a Chriſtian, I could not rationally build any poſitive doctrine upon mere revelation, which would have been judged a foreign principle in this inquiry: only, ſince the perſon, I intentionally addreſſed my thoughts to, under the name of *Eleutherius*, was a good Chriſtian, I held it not impertinent, now and then, upon the by, to intimate ſomething to prevent or remove ſome ſcruples, that I thought he might have on the ſcore (I ſay not of natural theology, for that is almoſt directly pertinent, but) of the Chriſtian faith. But theſe paſſages are very few, and but tranſiently touched upon.

Since the reader will be told by and by both that, and why the papers, that make up the following treatiſe, were not written in one continued ſeries of times, but many years were interpoſed between the writing of ſome of them, and that of thoſe, which precede and follow them; I hope it will be thought but a venial fault, if the contexture of the whole diſcourſe do not appear ſo uniform, nor all the connections of its parts ſo apt and cloſe, as, if no papers had been loſt and ſupplied, might reaſonably be looked for.

I expect the novelty of divers of the ſentiments and reaſonings propoſed in the following diſcourſe will be ſurpriſing, and incline many to look upon the author, as a bold man, and much addicted to paradoxes. But having formerly, in a diſtinct eſſay, delivered my thoughts about paradoxes in general, I ſhall not now ingage in that ſubject, but confine myſelf to what concerns the enſuing paper. I ſay then, in ſhort, that in an opinion, I look upon its being new or antient, and its being ſingular or commonly received, as things, that are but extrinſical to its being true or falſe: and, as I would never reject a truth, for being generally known or received; ſo will I not conclude an opinion to be a truth, merely becauſe great numbers have thought it to be ſo; nor think an opinion erroneous, becauſe it is not yet known to many, or becauſe it oppoſes a tenet embraced by many. For I am wont to judge of opinions, as of coins: I conſider much leſs in any one, that I am to receive, whoſe inſcription it bears, than what metal it is made of. It is indifferent enough to me, whether it was ſtamped many years or ages ſince, or came but yeſterday from the *Mint*. Nor do I regard through how many, or how few, hands it has paſſed for current, provided I know by the touch-ſtone, or any ſuch trial, purpoſely made, whether or no it be genuine, and does or does not deſerve to have been current: for, if upon due proof, it appears to be good, its having been long and by many received for ſuch, will not tempt me to refuſe it. But if I find it counterfeit, neither the prince's image or inſcription, nor its date (how antient ſoever,) nor the multitude of hands, through which it has paſſed unſuſpected, will engage me to receive it; and one diſfavouring trial, well made, will much more diſcredit it with me, than all thoſe ſpecious things I have named can recommend.

By this declaration of my ſentiments about paradoxes in general, I hope it will be thought, that the motive I had to queſtion that notion of nature, which I diſſent from, was not, that this notion is vulgarly received. And I have this to ſay, to make it probable, that I was not ingaged in this controverſy by any ambition of appearing in print an hereſiarch in philoſophy, by being the author of a ſtrange doctrine, that the following diſcourſe was written about the year 1666. (that is, ſome luſtres ago,) and that not long after the youth, to whom I dictated it, having been inveigled to ſteal away, unknown to me or his parents, into the *Indies*, (whence we never heard of him ſince,) left the looſe ſheets, wherein (and not in a book) my thoughts had been committed to paper, very incoherent, by the omiſſion of divers neceſſary paſſages. Upon which account, and my unwillingneſs to take the pains to ſupply what was wanting, thoſe papers lay by me many years together neglected, and almoſt forgotten; until the curioſity of ſome philoſophical heads, that were pleaſed to think they deſerved another fate, obliged me to tack them together, and make up the gaps, that remained between their parts, by retrieving, as well as after ſo many years my bad memory was able to do, the thoughts I ſometimes had pertinent to thoſe purpoſes. And indeed, when I conſidered of how vaſt importance it is in philoſophy, and the practice of phyſic too, to have a right notion of nature; and how little the authority of the generality of men ought, in ſo nice and intricate a ſubject, to ſway a free and impartial ſpirit; as I at firſt thought myſelf obliged, ſince others had not ſaved me the labour, to make a free inquiry into this noble and difficult ſubject, ſo I was afterwards the more eaſily prevailed with by thoſe, that preſſed the publication of it. With what ſucceſs I have made this attempt, I muſt leave others to judge. But if I be not much flattered, whatever becomes of the main attempt, there will be found ſuggeſted here and there, in the following diſcourſe, ſome reflections and explications, that will at leaſt oblige the zealous aſſertors of the vulgar notion of nature to clear up the doctrine, and ſpeak more diſtinctly and correctly about things, that relate to it, than hitherto has been uſual; and that will be fruit enough to recompenſe the labour, and juſtify the title of a free inquiry: in proſecution of which, ſince I have been obliged to travel in an untrodden way, without a guide, it will be thought, I hope, more pardonable than ſtrange, if, in attempting to diſcover divers general miſtakes, I be not ſo happy as to eſcape falling into ſome particular ones myſelf; and, if among theſe, I have been ſo unhappy, as to make any, that is injurious to religion, as I did not at all intend it, ſo, as ſoon as ever I ſhall diſcover it, I ſhall freely diſown it myſelf, and pray that it may never miſlead others. What my performance has been, I have already acknowledged, that I may be unfit to judge; but, for my intentions, I may make bold to ſay, they were to keep the glory of the divine author of things from being uſurped or intrenched upon by his creatures, and to make his works more throughly and ſolidly underſtood by the philoſophical ſtudiers of them.

I do not pretend, and I need not, that every one of the arguments I employ in the following tract is cogent, eſpecially if conſidered as ſingle. For demonſtrative arguments would be unſuitable to the very title of my attempt; ſince, if about the received notion of nature, I were furniſhed with unanſwerable reaſons, my diſcourſe ought to be ſtiled, not a free inquiry into the vulgar notion of nature I conſider, but a confutation of it; and a heap of bare probabilities may ſuffice to juſtify a doubt of the truth of an opinion, which they cannot clearly evince to be falſe. And therefore, if any man ſhall think fit to criticize upon the leſs principal or leſs neceſſary parts of this treatiſe, perhaps I ſhall not think myſelf obliged to be concerned at it: and even if the main body of the diſcourſe itſelf ſhall be attacked from the preſs; I, who am neither young nor healthy, nor ever made divinity, philoſophy, or phyſic, my profeſſion, am not like to oppoſe him in the ſame way: ſince, as I ought not to wiſh, that any errors of mine (if this eſſay teach any ſuch,) ſhould prevail; ſo, if the things I have delivered be true for the main, I need not deſpair, but that, in ſuch a free and inquiſitive age as ours, there will be found generous ſpirits, that will not ſuffer weighty truths to be oppreſſed, though the propoſers of them ſhould, by averſeneſs from contention, or by want of time or health, be themſelves kept from defending them: which I have thought fit to take notice of in this place, that the truth (if I have been ſo happy, as to have found and taught it,) may not ſuffer by my ſilence; nor any reader ſurmize, that if I ſhall leave a book unanſwered, I thereby acknowledge it to be unanſwerable. But this regards only the main ſubſtance of our eſſay, not the order or diſpoſition of the parts; ſince, if any ſhall cenſure that, I ſhall not quarrel with him about it: for indeed, conſidering in how prepoſterous an order the papers I have here tacked together came to hand, and how many things are upon that ſcore unduly placed, I ſhall not only be content, but muſt deſire to have this rhapſody of my own looſe papers looked upon but as an apparatus, or collection of materials, in order to [what I well know this maimed and confuſed eſſay is not,] a compleat and regular diſcourſe. Yet, (to conclude,) I thought, that the affording even of a little light, in a ſubject ſo dark and ſo very important, might keep an eſſay from being uſeleſs; and that to fall ſhort of demonſtration would prove a pardonable fault in a diſcourſe, that pretends not to dogmatize, but only to make an inquiry.

Sept. 29, 1682.

A Free

A FREE INQUIRY into the received NOTION of NATURE.

SECT. I.

I KNow not, whether or no it be a prerogative in the human ſoul, that as it is itſelf a true and poſitive Being, ſo it is apt to conceive all other things, as true and poſitive beings alſo: but, whether or no this propenſity to frame ſuch kind of ideas ſuppoſes an excellency, I fear it occaſions miſtakes, and makes us think and ſpeak, after the manner of true and poſitive beings, of ſuch things, as are but chimerical, and ſome of them negations or privations themſelves; as death, ignorance, blindneſs, and the like.

IT concerns us therefore to ſtand very carefully upon our guard, that we be not inſenſibly miſled by ſuch an innate and unheeded temptation to error, as we bring into the world with us; and conſequently I may be allowed to conſider, whether among other particulars, in which this deluding propenſity of our minds has too great, though unſuſpected, an influence upon us, it may not have impoſed on us, in the notion we are wont to frame concerning nature: for this being the fruitful parent of other notions, as nature herſelf is ſaid to be of the creatures of the univerſe; the notion is ſo general in its applications, and ſo important in its influence, that we had need be jealouſly careful of not over-eaſily admitting a notion, than which there can ſcarce be any, that more deſerves to be warily examined, before it be throughly entertained.

LET me therefore make bold to inquire freely, whether that, of which we affirm ſuch great things, and to which we aſcribe ſo many feats, be that almoſt divine thing, whoſe works, among others, we are; or a notional thing, that in ſome ſenſe is rather to be reckoned among our works, as owing its being to human intellects.

I KNOW moſt men will be foreſtalled with no mean prejudices againſt ſo venturous an attempt; but I will not do *Eleutherius* the injury to meaſure him by the prepoſſeſſed generality of men; yet there are two ſcruples, which I think it not amiſs to take notice of, to clear the way for what ſhall be preſented you in the following diſcourſe.

AND firſt, it may ſeem an ingrateful and unfilial thing to diſpute againſt nature, that is taken by mankind for the common parent of us all. But though it be an undutiful thing, to expreſs a want of reſpect for an acknowledged parent, yet I know not, why it may not be allowable to queſtion one, that a man looks upon but as a pretended one, or at leaſt does upon probable grounds doubt, whether ſhe be ſo or no; and until it appear to me, that ſhe is ſo, I think it my duty to pay my gratitude, not to I know not what, but to that deity, whoſe wiſdom and goodneſs, not only deſigned to make me a man, and enjoy what I am here bleſſed with, but contrived the world ſo, that even thoſe creatures of his, who by their inanimate condition are not capable of intending to gratify me, ſhould be as ſerviceable and uſeful to me, as they would be, if they could and did deſign the being ſo: and you may be pleaſed to remember, that, as men may now accuſe ſuch an inquirer, as I am, of impiety and ingratitude towards nature; ſo the Perſians, and other worſhippers of the cœleſtial bodies, accuſed ſeveral of the antient philoſophers, and all the primitive Chriſtians, of the like crimes, in reference to the ſun; whoſe exiſtence, and whoſe being a benefactor to mankind was far more unqueſtionable, than that there is ſuch a ſemi-deity, as men call nature: and it can be no great diſparagement to me, to ſuffer on the like account with ſo good company, eſpecially when ſeveral of the conſiderations, that juſtify them, may alſo apologize for me. I might add, that it not being half ſo evident to me, that what is called nature is my parent, as that all men are my brothers, by being the off-ſpring of God; Acts xvii.
(for the τοῦ γὰρ γένος ἐσμὲν of *Aratus* is adopted by St. *Paul*) I may juſtly prefer the doing of them a ſervice, by diſabuſing them, to the paying of her a ceremonial reſpect. But ſetting allegories aſide, I have ſometimes ſeriouſly doubted, whether the vulgar notion of nature has not been both injurious to the glory of God, and a great impediment to the ſolid and uſeful diſcovery of his works.

AND firſt, it ſeems to detract from the honour of the great author and governor of the world, that men ſhould aſcribe moſt of the admirable things, that are to be met with in it, not to him, but to a certain nature, which themſelves do not well know what to make of. It is true, that many confeſs, that this nature is a thing of his eſtabliſhing, and ſubordinate to him: but, though many confeſs it, when they are aſked, whether they do or no? yet, beſides that many ſeldom or never lifted up their eyes to any higher cauſe, he, that takes notice of their way of aſcribing things to nature, may eaſily diſcern, that, whatever their words ſometimes be, the agency of God is little taken notice of in their thoughts: and however, it does not a little darken the excellency of the divine management of things, that, when a ſtrange thing is to be accounted for, men ſo often have recourſe to nature, and think ſhe muſt extraordinarily interpoſe to bring ſuch things about; whereas it much more tends to the illuſtration of God's wiſdom, to have ſo framed things at firſt, that there can ſeldom or never need any extraordinary interpoſition of his power. And, as it more recommends the ſkill of an engineer to contrive an elaborate engine ſo, as that there ſhould need nothing to reach his ends in it but the contrivance of parts devoid of underſtanding, than if it were neceſſary, that ever and anon a diſcreet ſervant ſhould be employed to concur notably to the operations of this or that part, or to hinder the engine from being out of order; ſo it more ſets off the wiſdom of God in the fabric of the univerſe, that he can make ſo vaſt a machine perform all thoſe many things, which he deſigned it ſhould, by the meer contrivance of brute matter managed by certain laws of local motion and upheld by his ordinary and general concourſe, than if he employed from time to time an intelligent overſeer, ſuch as nature is fancied to be, to regulate, aſſiſt, and controul the motions of the parts: in confirmation of which you may remember, that the later poets juſtly reprehended their predeceſſors for want of ſkill in laying the plots of their plays, becauſe they often ſuffered things to be reduced to that paſs, that they were fain to bring ſome deity (Θεὸς ἀπὸ μηχανῆς) upon the ſtage, to help them out.

(*Nec deus interſit, niſi dignus vindice nodus*,) &c.

And let me tell you freely, that though I will not ſay, that *Ariſtotle* meant the miſchief his doctrine did, yet I am apt to think, that the grand enemy of God's glory made great uſe of *Ariſtotle*'s authority and errors, to detract from it.

For as *Ariſtotle*, by introducing the opinion of the eternity of the world, (whereof he owns himſelf to have been the firſt broacher) did, at leaſt in almoſt all men's opinion, openly deny God the production of the world; ſo, by aſcribing the admirable works of God to what he calls nature, he tacitly denies him the government of the world: which ſuſpicion if you judge ſevere, I ſhall not, at more leiſure, refuſe to acquaint you, (in a diſtinct paper) why I take divers of *Ariſtotle*'s opinions relating to religion to be more unfriendly, not to ſay pernicious, to it, than thoſe of ſeveral other heathen philoſophers.

And here give me leave to prevent an objection, that ſome may make, as if to deny the received notion of nature, a man muſt alſo deny providence, of which nature is the grand inſtrument. For, in the firſt place, my opinion hinders me not at all from acknowledging God to be the author of the univerſe, and the continual preſerver and upholder of it; which is much more than the peripatetic hypotheſis, which (as we were ſaying) makes the world eternal, will allow its embracers to admit: and thoſe things, which the ſchool-philoſophers aſcribe to the agency of nature interpoſing according to emergencies, I aſcribe to the wiſdom of God in the firſt fabric of the univerſe, which he ſo admirably contrived, that, if he but continue his ordinary and general concourſe, there will be no neceſſity of extraordinary interpoſitions, which may reduce him to ſeem, as it were, to play after-games; all thoſe exigencies, upon whoſe account philoſophers and phyſicians ſeem to have deviſed what they call nature, being foreſeen and provided for in the firſt fabric of the world; ſo that mere matter, ſo ordered, ſhall, in ſuch and ſuch conjunctures of circumſtances, do all, that philoſophers aſcribe on ſuch occaſions to their almoſt omniſcient nature, without any knowledge of what it does, or acting otherwiſe than according to the catholic laws of motion. And methinks the difference betwixt their opinion of God's agency in the world, and that, which I would propoſe, may be ſomewhat adumbrated by ſaying, that they ſeem to imagine the world to be after the nature of a puppet, whoſe contrivance indeed may be very artificial, but yet is ſuch, that almoſt every particular motion the artificer is fain (by drawing ſometimes one wire or ſtring, ſometimes another) to guide, and oftentimes over-rule the actions of the engine; whereas, according to us, it is like a rare clock, ſuch as may be that at *Straſburgh*, where all things are ſo ſkilfully contrived, that the engine being once ſet a moving, all things proceed, according to the artificer's firſt deſign, and the motions of the little ſtatues, that at ſuch hours perform theſe or thoſe things, do not require, like thoſe of puppets, the peculiar interpoſing of the artificer, or any intelligent agent employed by him, but perform their functions upon particular occaſions, by virtue of the general and primitive contrivance of the whole engine. The modern *Ariſtotelians* and other philoſophers would not be taxed as injurious to providence, though they now aſcribe to the ordinary courſe of nature thoſe regular motions of the planets, that *Ariſtotle* and moſt of his followers (and among them the Chriſtian ſchoolmen) did formerly aſcribe to the particular guidance of intelligent and immaterial beings, which they aſſigned to be the motives of the cœleſtial orbs. And when I conſider, how many things, that ſeem anomalies to us, do frequently enough happen in the world, I think it is more conſonant to the reſpect we owe to divine providence, to conceive, that as God is a moſt free, as well as a moſt wiſe agent, and may in many things have ends unknown to us, he very well foreſaw, and thought fit, that ſuch ſeeming anomalies ſhould come to paſs, ſince he made them (as is evident in the eclipſes of the ſun and moon) the genuine conſequences of the order he was pleaſed to ſettle in the world; by whoſe laws the grand agents in the univerſe were impowered and determined to act, according to the reſpective natures he had given them, and the courſe of things was allowed to run on, though that would infer the happening of ſeeming anomalies, and things really repugnant to the good or welfare of divers particular portions of the univerſe: this, I ſay, I think to be a notion more reſpectful to divine providence, than to imagine, as we commonly do, that God has appointed an intelligent and powerful Being, called nature, to be, as his vicegerent, continually watchful for the good of the univerſe in general, and of the particular bodies, that compoſe it; whilſt, in the mean time, this Being appears not to have the ſkill, or the power, to prevent ſuch anomalies, which oftentimes prove deſtructive to multitudes of animals, and other noble creatures, (as in plagues, *&c.*) and ſometimes prejudicial to greater portions of the univerſe, (as in earthquakes of a large ſpread, eclipſes of the luminaries, great and laſting ſpots on the ſun, eruptions of vulcan, great comets, or new ſtars, that paſs from one region of Heaven to another.) And I am the more tender of admitting ſuch a lieutenant to divine providence, as nature is fancied to be, becauſe I ſhall hereafter give you ſome inſtances, in which it ſeems, that, if there were ſuch a thing, ſhe muſt be ſaid to act too blindly and impotently, to diſcharge well the part ſhe is ſaid to be truſted with.

I SHALL add, that the doctrine I plead for does much better, than its rival, comply with what religion teaches us about the extraordinary and ſupernatural interpoſitions of divine providence. For when it pleaſes God to over-rule, or controul, the eſtabliſhed courſe of things in the world, by his own omnipotent hand, what is thus performed may be much eaſier diſcerned and acknowledged to be miraculous by them, that admit, in the ordinary courſe of corporeal things, nothing but matter and motion, whoſe powers men may well judge of, than by thoſe, who think there is beſides a certain ſemi-deity, which they call nature, whoſe ſkill and power they acknowledge to be exceeding great, and yet have no ſure way of eſtimating, how great they are, and how far they may extend. And give me leave to take notice to you, on this occaſion, that I obſerve the miracles of our Saviour and his Apoſtles, pleaded by Chriſtians on the behalf of their religion, to have been very differingly looked on by Epicurean and other corpuſcularian infidels, and by thoſe other unbelievers, who admit of a ſoul of the world, or ſpirits in the ſtars, or, in a word, think the univerſe to be governed by intellectual beings diſtinct from the ſupreme being we call God: for this latter ſort of infidels have often admitted thoſe matters of fact, which we Chriſtians call miracles, and yet have endeavoured to ſolve them by aſtral operations, and other ways not here to be ſpecified; whereas the Epicurean enemies of Chriſtianity have thought themſelves obliged reſolutely to deny the matters of fact themſelves, as well diſcerning, that the things ſaid to be performed exceeded the mechanical powers of matter and motion, (as they were managed by thoſe, that wrought the miracles,) and conſequently muſt either be denied to have been done, or be confeſſed to have been truly miraculous. But there may hereafter be occaſion, both to improve the things already ſaid, and add others, to ſatisfy theological ſcruples about our hypotheſis.

See the III, the IV, and alſo the laſt Section of this Treatiſe.

I FORMERLY told you, that it was not only to the glory of God, (as that reſults from his wiſdom, power and goodneſs, expreſſed in the world) that I ſuſpected the notion of nature, that I am examining, to be prejudicial, but alſo to the diſcovery of his works. And you will make no great difficulty to believe me, if you conſider, that, whilſt men allow themſelves ſo general and eaſy a way of rendring accounts of things, that are difficult, as to attribute them to nature, ſhame will not reduce them to a more induſtrious ſcrutiny into the reaſons of things, and curioſity itſelf will move them to it the more faintly: of which we have a clear and eminent example in the aſcenſion of water in pumps, and in other phænomena of that kind, whoſe true phyſical cauſes had never been found out, if the moderns had acquieſced, as their predeceſſors did, in that imaginary one, that the world was governed by a watchful being, called nature, and that ſhe abhors a vacuum, and conſequently is ſtill in a readineſs to do irreſiſtibly whatever is neceſſary to prevent it; nor muſt we expect any great progreſs in the diſcovery of the true cauſes of natural effects, whilſt we are content to ſit down with other, than the particular and immediate ones.

IT is not, that I deny, that there are divers things, as the number and ſituation of the ſtars, the ſhapes and ſizes of animals, *&c.* about which even a philoſopher being aſked can ſay little, but that it pleaſed the author of the univerſe to make them ſo; but when we give ſuch general anſwers, we pretend not to give the particular phyſical reaſons of the things propoſed, but do in effect confeſs we do not know them. To this I add, that the veneration, wherewith men are imbued for what they call nature, has been a diſcouraging impediment to the empire of man over the inferior creatures of God: for many have not only looked upon it, as an impoſſible thing to compaſs, but as ſomething of impious to attempt, the removing of thoſe boundaries, which nature ſeems to have put and ſettled among her productions; and whilſt they look upon her as ſuch a venerable thing, ſome make a kind of ſcruple of conſcience to endeavour ſo to emulate any of her works, as to excel them.

I HAVE ſtaid ſo long about removing the firſt of the two ſcruples I formerly propoſed againſt my preſent attempt, that, not to tire your patience, I ſhall in few words diſpatch the ſecond; which is, that I venture to contradict the ſenſe of the generality of mankind: to which I anſwer, that in philoſophical inquiries, it becomes not a naturaliſt to be ſo ſolicitous, what has been, or is believed, as what ought to be ſo; and I have alſo elſewhere, on another occaſion, ſhewed, how little the ſenſe of the generality of men ought to ſway us in ſome queſtions. But that, which I ſhall at preſent more directly reply, is, firſt, that it is no wonder

der men ſhould be generally prepoſſeſt with ſuch a notion of nature, as I call in queſtion, ſince education (eſpecially in ſchools) has imbued them with it from their infancy, and even in their maturer years they find it taken for granted, and employed not only by the moſt but by the learnedeſt writers, and never hear it called in queſtion by any: and then it exceedingly complies with our innate propenſity to think, that we know more than we do, and to appear to do ſo; for to vouch nature for a cauſe, is an expedient, that can ſcarce be wanting to any man, upon any occaſion, to ſeem to know, what he can indeed render no good reaſon of.

AND to this firſt part of my anſwer, I ſhall ſubjoin this ſecond: that the general cuſtom of mankind to talk of a thing as a real and poſitive being, and attribute great matters to it, does but little weigh with me, when I conſider, that, though fortune be not any phyſical thing, but a certain looſe and undetermined notion, which a modern metaphyſician would refer to the claſſis of his non entia; yet not only the Gentiles made it a Goddeſs,

> (*Nos te facimus, fortuna, deam, cœloque locamus,*)

which many of them ſeriouſly worſhipped, but eminent writers, in verſe and in proſe, ethnick and Chriſtian, ancient and modern, and all ſorts of men in their common diſcourſe, do ſeriouſly talk of it, as if it were a kind of Antichriſt, that uſurped a great ſhare in the government of the world, and aſcribe little leſs to it, than they do to nature. And not to ſpeak of what poets, moraliſts and divines tell us of the powers of ignorance and vice, which are but moral defects, let us conſider, what things are not only by theſe men, but by the generality of mankind, ſeriouſly attributed to death, to which ſo great and fatal a dominion is aſſigned; and then if we conſider too, that this death, which is ſaid to do ſo many and ſuch wonderful things, is neither a ſubſtance, nor a poſitive entity, but a meer privation; we ſhall, I truſt, the leſs believe, that the feats aſcribed to nature do infer, that there is really ſuch a phyſical agent, as is ſuppoſed.

AND now having, as I preſume, cleared our inquiry, as far as it is yet neceſſary, [and it will be further done hereafter] from thoſe prejudices, that might make the attempt be cenſured before it be examined, I proceed to the inquiry itſelf; wherein I ſhall endeavour (but with the brevity my want of leiſure exacts) to do theſe ſix things. *Firſt*, to give you a ſhort account of the great ambiguity of the word nature, ariſing from its various acceptions. *Secondly*, to ſhew you, that the definition alſo, that *Ariſtotle* himſelf gives of nature, does not afford a clear or ſatisfactory notion of it. *Thirdly*, to gather from the ſeveral things, that are wont to be affirmed of, or attributed to, nature, the received notion of it, which cannot be well gathered from the name, becauſe of its great ambiguity. *Fourthly*, I will mention ſome of thoſe reaſons, that diſſuade me from admitting this notion of nature. *Fifthly*, I ſhall endeavour to anſwer ſeverally the chief things, upon which men ſeem to have taken up the idea of nature, that I diſallow. And, *Sixthly*, I ſhall propoſe ſome of the chief effata or axioms, that are wont to be made uſe of, concerning nature in general, and ſhall ſhew, how far, and in what ſenſe, I may admit them.

AND here it may be opportune, to prevent both miſtakes and the neceſſity of interrupting the ſeries of our diſcourſe, to ſet down two or three advertiſements.

1. WHEN any where in this tract I ſpeak of the opinion of *Ariſtotle* and the Peripatetics, as I would not be thought to impute to him all the ſentiments of thoſe, that will be thought his followers, ſome of which ſeem to me to have much miſtaken his true meaning; ſo (on the other ſide) I did not conceive, that my deſign obliged me to inquire anxiouſly into his true ſentiments, whether about the origin of the univerſe, (as whether or no it were ſelf-exiſtent, as well as eternal) or about leſs important points: ſince, beſides that his expreſſions are oftentimes dark and ambiguous enough, and the things he delivers in ſeveral paſſages do not ſeem always very conſiſtent; it ſufficed for my purpoſe, which was to queſtion vulgar notions, to examine thoſe opinions, that are by the generality of ſcholars taken for the *Ariſtotelian* and Peripatetic doctrines, by which, if he be miſ-repreſented, the blame ought to light upon his commentators and followers.

2. THE rational ſoul or mind of man, as it is diſtinct from the ſenſitive ſoul, being an immaterial ſpirit, is a ſubſtance of ſo heteroclite a kind, in reference to things ſo vaſtly differing from it, as mere bodies are, that ſince I could neither, without injuring it, treat of it promiſcuouſly with the corporeal works of God, nor ſpeak worthily of it, without frequently interrupting and diſordering my diſcourſe by exceptions, that would either make it appear intricate, or would be very troubleſome to you or any other, that you may think fit to make my reader; I thought I might, for others eaſe and my own, be allowed to ſet aſide the conſiderations of it in the preſent treatiſe; and the rather, becauſe all other parts of the univerſe being, according to the received opinion, the works of nature, we ſhall not want in them ſubjects more than ſufficiently numerous, whereon to make our examen; though I ſhall here conſider the world but as the great ſyſtem of things corporeal, as it once really was towards the cloſe of the ſixth day of the creation, when God had finiſhed all his material works, but had not yet created man.

SECT. II.

I. A CONSIDERING perſon may well be tempted to ſuſpect, that men have generally had but imperfect and confuſed notions concerning nature; if he but obſerves, that they apply that name to ſeverall things, and thoſe too ſuch, as have ſome of them very little dependance on, or connexion with, ſuch others. And I remember, that in *Ariſtotle*'s Metaphyſicks, I met with a whole chapter expreſly written to enumerate the various acceptions of the Greek word, φύσις, commonly rendered nature; of which, if I miſtake not, he there reckons up ſix. In *Engliſh* alſo we have not fewer, but rather more numerous ſignifications of that term: for ſometimes we uſe the word nature for that author of nature, whom the ſchoolmen, harſhly enough, call *natura naturans*; as when it is ſaid, that nature hath made man partly corporeal, and partly immaterial. Sometimes we mean by the nature of a thing, the eſſence, or that, which the ſchoolmen ſcruple not to call the quiddity of a thing, namely, the attribute or attributes, on whoſe ſcore it is, what it is, whether the thing be corporeal or not; as, when we attempt to define the nature of an angle, or of a triangle, or of a fluid body, as ſuch. Sometimes we confound that, which a man has by nature, with what accrues to him by birth; as, when we ſay, that ſuch a man is noble by nature, or ſuch a child naturally forward, or ſickly, or frightful. Sometimes we take nature for an internal principle of motion; as, when we ſay, that a ſtone let fall in the air is by nature carried towards the centre of the earth; and, on the contrary, that fire or flame does naturally move upwards towards Heaven.

Sometimes we underſtand by nature the eſtabliſhed courſe of things; as, when we ſay, that nature makes the night ſucceed the day; nature hath made reſpiration neceſſary to the life of men.

Sometimes we take nature for an aggregate of powers belonging to a body, eſpecially a living one; as, when phyſicians ſay, that nature is ſtrong, or weak, or ſpent; or that in ſuch or ſuch diſeaſes, nature left to herſelf will do the cure. Sometimes we take nature for the univerſe, or ſyſtem of the corporeal works of God; as, when it is ſaid of a phenix, or a chimera, that there is no ſuch thing in nature, (*i. e.*) in the world. And ſometimes too, and that moſt commonly, we would expreſs by the word nature a ſemi-deity, or other ſtrange kind of being, ſuch as this diſcourſe examines the notion of. And beſides theſe more abſolute acceptions, if I may ſo call them, of the word nature, it has divers others, (more relative,) as nature is wont to be ſet in oppoſition or contradiſtinction to other things; as when we ſay of a ſtone, when it falls downwards, that it does it by a natural motion; but that if it be thrown upwards, its motion that way is violent. So chymiſts diſtinguiſh vitriol into natural, and fictitious, or made by art, (*i. e.*) by the intervention of human power or ſkill: ſo it is ſaid, that water, kept ſuſpended in a ſucking pump is not in its natural place, as that is, which is ſtagnant in the well. We ſay alſo, that wicked men are ſtill in the ſtate of nature, but the regenerate in a ſtate of grace: that cures, wrought by medicines, are natural operations; but the miraculous ones, wrought by Chriſt and his apoſtles, were ſupernatural. Nor are theſe the only forms of ſpeech, that a more diligent collector, than I think it neceſſary I ſhould here be, might inſtance in, to manifeſt the ambiguity of the word nature, by the many and various things it is applied to ſignify, though ſome of thoſe already mentioned ſhould be judged too near to be co-incident. Among *Latin* writers I found the acceptions of the word nature to be ſo many, that I remember one author reckons up no leſs than fourteen or fifteen. From all which it is not difficult to gather, how eaſy it is for the generality of men, without excepting thoſe, that write of natural things, to impoſe upon others and themſelves, in the uſe of a word ſo apt to be miſ-employed.

On this occaſion I can ſcarce forbear to tell you, that I have often looked upon it as an unhappy thing, and prejudicial both to philoſophy and phyſick, that the word nature hath been ſo frequently, and yet ſo unſkilfully employed, both in books and in diſcourſe, by all ſorts of men, learned and illiterate. For the very great ambiguity of this term, and the promiſcuous uſe men are wont to make of it, without ſufficiently attending to its different ſignifications, makes many of the expreſſions, wherein they employ it, (and think they do it well and truly) to be either not intelligible, or not proper, or not true: which obſervation, though it be not heeded, may, with the help of a little attention, be eaſily verified; eſpecially becauſe the term nature is ſo often uſed, that you ſhall ſcarce meet with any man, who, if he have occaſion to diſcourſe any thing long of either natural or medicinal ſubjects, would not find himſelf at a great loſs, if he were prohibited the uſe of the word nature, and of thoſe phraſes, whereof it makes the principal part. And I confeſs I could heartily wiſh, that philoſophers, and other learned men (whom the reſt in time would follow) would by common (though perhaps tacit) conſent, introduce ſome more ſignificant, and leſs ambiguous terms and expreſſions in the room of the too licenciouſly abuſed word nature, and the forms of ſpeech, that depend on it; or would, at leaſt, decline the uſe of it, as much as conveniently they can; and where they think they muſt employ it, would add a word or two, to declare in what clear and determinate ſenſe they uſe it. For without ſomewhat of this kind be done, men will very hardly avoid being led into divers miſtakes, both of things, and of one another; and ſuch wranglings about words and names will be (if not continually multiplied) ſtill kept on foot, as are wont to be managed with much heat, though little uſe, and no neceſſity.

And here I muſt take leave to complain, in my own excuſe, of the ſcarce ſuperable difficulty of the taſk, that the deſign of a free inquiry puts me upon. For it is far more difficult, than any one, that hath not tried, (and I do not know that any man hath,) would imagine, to diſcourſe long of the corporeal works of God, and eſpecially of the operations and phænomena, that are attributed to nature, and yet decline making oftentimes uſe of that term, or forms of ſpeech, whereof it is a main part, without much more frequent, and perhaps tedious, circumlocutions, than I am willing to trouble you with. And therefore I hope you will eaſily excuſe me, if, partly to ſhun theſe, and to avoid uſing often the ſame words too near one another, and partly out of unwillingneſs to employ vulgar terms likely to occaſion or countenance vulgar errors; I have ſeveral times been fain to uſe paraphraſes, or other expreſſions, leſs ſhort than thoſe commonly received; and ſometimes for one or other of theſe reaſons, or out of inadvertence, miſſed of avoiding the terms uſed by thoſe, that admit and applaud the vulgar notion of nature; whom, I muſt here advertiſe you, that partly becauſe they do ſo, and partly for brevity's ſake, I ſhall hereafter many times call naturiſts: which appellation I rather chuſe than that of naturaliſts, becauſe many, even of the learned among them, as logicians, orators, lawyers, arithmeticians, *&c.* are not phyſiologers.

But if on this occaſion you ſhould be very urgent to know, what courſe I would think expedient, if I were to propoſe any, for the avoiding the inconvenient uſe of ſo ambiguous a word, as nature; I ſhould firſt put you in mind, that having but very lately declared, that I thought it very difficult, in phyſiological diſcourſes eſpecially, to decline the frequent uſe of that term, you are not to expect from me the ſatisfaction you may deſire in an anſwer; and then I would add, that yet my unwillingneſs to be altogether ſilent, when you require me to ſay ſomewhat, makes me content to try, whether the miſchief complained of may not be in ſome meaſure either obviated or leſſened, by looking back upon the (eight) various ſignifications, that were not long ſince delivered of the word nature, and by endeavouring to expreſs them in other terms, or forms of ſpeech.

1. Instead then of the word nature, taken in the firſt ſenſe, [for *natura naturans*,] we may make uſe of the term it is put to ſignify, namely, God; wholly diſcarding an expreſſion, which, beſides that it is harſh and needleſs, and in uſe only among the ſchoolmen, ſeems not to me very ſuitable to the profound reverence we owe the divine majeſty; ſince it ſeems to make the creator differ too little by far from a created (not to ſay an imaginary) Being.

2. Instead of nature in the ſecond ſenſe, [for, *That, on whoſe account a thing is what it is, and is ſo called*,] we may employ the word eſſence, which is of great affinity to it, if not of an adequate import: and ſometimes alſo we may make uſe of the word quiddity, which, though a ſomewhat barbarous term, is yet frequently employed, and well enough underſtood, in the ſchools; and, which is more conſiderable, is very comprehenſive, and yet free enough from ambiguity.

3. What is meant by the word nature taken in the third ſenſe of it, [for *what belongs to a living creature at its nativity, or accrues to it by its birth*,] may be expreſſed ſometimes by ſaying, that a man or other animal is born ſo; and ſometimes by ſaying, that a thing has been generated ſuch; and ſometimes alſo, that it is thus or thus qualified by its original temperament and conſtitution.

4. Instead of the word nature taken in the fourth acception [for, an *internal principle of local motion*] we may ſay ſometimes, that this or that body moves as it were, or elſe that it ſeems to move, ſpontaneouſly (or of its own accord) upwards, downwards, *&c.* or, that is put into this or that motion, or determined to this or that action, by the concourſe of ſuch or ſuch (proper) cauſes.

5. For nature in the fifth ſignification, [for, the *eſtabliſhed courſe of things corporeal*] it is eaſy to ſubſtitute what it denotes, *the eſtabliſhed order*, or *the ſettled courſe of things*.

6. Instead of nature in the ſixth ſenſe of the word [for, *an aggregate of the powers belonging to a body, eſpecially a living one*] we may employ the conſtitution, temperament, or the mechaniſm, or the complex of the eſſential properties or qualities; and ſometimes the condition, the ſtructure, or the texture of that body: and if we ſpeak of the greater portions of the world, we may make uſe of one or other of theſe terms, *Fabric of the world, ſyſtem of the univerſe, coſmical mechaniſm*, or the like.

7. Where men are wont to employ the word nature in the ſeventh ſenſe [for the *univerſe*, or the *ſyſtem of the corporeal works of God*] it is eaſy, and as ſhort, to make uſe of the word world or univerſe, and inſtead of the phænomena of nature, to ſubſtitute the phænomena of the univerſe, or of the world.

8. And, as for the word nature taken in the eighth and laſt of the fore-mentioned acceptions [for, either (as ſome Pagans ſtiled her) a goddeſs, or a kind of ſemi-deity] the beſt way is not to employ it in that ſenſe at all, or at leaſt as ſeldom as may be; and that for divers reaſons, which may in due place be met with in ſeveral parts of this eſſay.

But though the foregoing diverſity of terms and phraſes may be much increaſed, yet I confeſs it makes but a part of the remedy I propoſe againſt the future miſchiefs of the confuſed acception of the word nature, and the phraſes grounded on it. For beſides the ſynonymous words, and more literal interpretations lately propoſed, a dexterous writer may oftentimes be able to give ſuch a form (or, as the modern *Frenchmen* ſpeak, ſuch a tour) to his many-ways variable expreſſions, as to avoid the neceſſity of making uſe of the word nature; or ſometimes ſo much as of thoſe ſhorter terms, that have been lately ſubſtituted in its place. And to all this I muſt add, that though one or two of the eight fore-mentioned terms or phraſes, as quiddity and coſmical mechaniſm, be barbarous or ungenteel, and ſome other expreſſions be leſs ſhort than the word nature; yet it is more the intereſt of philoſophy to tolerate a harſh term, that has been long received in the ſchools in a determinate ſenſe, and bear with ſome paraphraſtical expreſſions, than not to avoid an ambiguity, that is liable to ſuch great inconveniencies, as have been lately, or may be hereafter, repreſented.

THERE are, I know, ſome learned men, who, (perhaps being ſtartled to find nature uſually ſpoken of ſo much like a kind of goddeſs,) will have the nature of every thing to be only the law, that it receives from the creator, and according to which it acts on all occaſions. And this opinion ſeems much of kin to, if not the ſame with that of the famous *Helmont*, who, juſtly rejecting the *Ariſtotelian* tenet of the contrariety or hoſtility of the elements, will have every body, without any ſuch reſpect, to act that, which it is commanded to act. And indeed this opinion about nature, though neither clear nor comprehenſive enough, ſeems capable of a fair conſtruction. And there is oftentimes ſome reſemblance between the orderly and regular motions of inanimate bodies, and the actions of agents, that, in what they do act, conformably to laws. And even I ſometimes ſcruple not to ſpeak of the laws of motion and reſt, that God has eſtabliſhed among other things corporeal, and now and then, (for brevity's ſake, or out of cuſtom) to call them, as men are wont to do, the laws of nature; having in due place declared, in what ſenſe I underſtand and employ theſe expreſſions.

BUT to ſpeak ſtrictly, (as becomes philoſophers, in ſo weighty a matter) to ſay, that the nature of this or that body is but *the law of God preſcribed to it*, is but an improper and figurative expreſſion: for, beſides that this gives us but a very defective idea of nature, ſince it omits the general fabric of the world, and the contrivances of particular bodies, which yet are as well neceſſary, as local motion itſelf, to the production of particular effects and phænomena; beſides this, I ſay, and other imperfections of this notion of nature, that I ſhall not here inſiſt on, I muſt freely obſerve, that, to ſpeak properly, a law being but a *notional rule of acting according to the declared will of a ſuperior*, it is plain, that nothing but an intellectual Being can be properly capable of receiving and acting by a law. For if it does not underſtand, it cannot know what the will of the legiſlator is; nor can it have any intention to accompliſh it, nor can it act with regard to it, or know when it does, in acting, either conform to it or deviate from it: and it is intelligible to me, that God ſhould at the beginning impreſs determinate motions upon the parts of matter, and guide them, as he thought requiſite, for the primordial conſtitution of things; and that ever ſince he ſhould, by his ordinary and general concourſe, maintain thoſe powers, which he gave the parts of matter, to tranſmit their motion thus and thus to one another. But I cannot conceive, how a body devoid of underſtanding and ſenſe, truly ſo called, can moderate and determinate its own motions, eſpecially ſo, as to make them conformable to laws, that it has no knowledge or apprehenſion of; and that inanimate bodies, how ſtrictly ſoever called natural, do properly act by laws, cannot be evinced by their ſometimes acting regularly, and, as men think, in order to determinate ends: ſince in artificial things we ſee many motions very orderly performed, and with a manifeſt tendency to particular and pre-deſigned ends; as in a watch, the motions of the ſpring, wheels, and other parts, are ſo contemperated and regulated, that the hand upon the dial moves with a great uniformity, and ſeems to moderate its motion ſo, as not to arrive at the points, that denote the time of the day, either in a minute ſooner, or a minute later, than it ſhould do, to declare the hour. And when a man ſhoots an arrow at a mark, ſo as to hit it, though the arrow moves towards the mark, as it would if it could and did deſign to ſtrike it, yet none will ſay, that this arrow moves by a law, but by an external, though well directed, impulſe.

SECT. III.

II. BUT poſſibly the definition of a philoſopher may exempt us from the perplexities, to which the ambiguous expreſſions of common writers expoſe us. I therefore thought fit to conſider, with a ſomewhat more than ordinary attention, the famous definition of nature, that is left us by *Ariſtotle*, which I ſhall recite rather in *Latin* than in *Engliſh*, not only becauſe it is very familiarly known among ſcholars in that language, but becauſe there is ſomewhat in it, that I confeſs ſeems difficult to me to be without circumlocution rendered intelligibly in *Engliſh*: *Natura* (ſays he) *eſt principium & cauſa motus & quietis ejus, in quo ineſt, primo per ſe, & non ſecundum accidens.* But though when I conſidered, that according to *Ariſtotle*, the whole world is but a ſyſtem of the works of nature, I thought it might well be expected, that the definition of a thing, the moſt important in natural philoſophy, ſhould be clearly and accurately delivered; yet to me this celebrated definition ſeemed ſo dark, that I cannot brag of any aſſiſtance I received from it towards the framing of a clear and ſatisfactory notion of nature. For I dare not hope, that what, as to me, is not itſelf intelligible, ſhould make me underſtand what

2 Phyſ. c. 1. l. 3.

is to be declared or explicated by it. And when I conſulted ſome of *Ariſtotle's* interpreters upon the ſenſe of this definition, I found the more conſiderate of them ſo puzzled with it, that their diſcourſes of it ſeemed to tend rather to free the maker of it from tautology and ſelf-contradiction, than to manifeſt, that the definition itſelf is good and inſtructive, and ſuch as affords a fair account of the thing defined. And indeed, though the immoderate veneration they cheriſh for their maſter engages them to make the beſt they can of the definition given to him, even when they cannot juſtify it without ſtrained interpretations, yet what every one ſeems to defend in groſs, almoſt every one of them cenſures in parcels; this man attacking one part of the definition, and that man another, with objections ſo weighty, (not to call ſome of them unanſwerable) that if I had no other arguments to urge againſt it, I might borrow enough from the commentators on it to juſtify my diſlike of it.

However, we may hereafter have occaſion to conſider ſome of the main parts of this definition, and in the mean while it may ſuffice, that we obſerve, that ſeveral things are commonly received, as belonging to the idea or notion of nature, that are not manifeſtly or not at all, comprehended in this *Ariſtotelian* definition, which doth not declare, whether the principle or cauſe (which expreſſion already makes the ſenſe doubtful) here mentioned is a ſubſtance, or an accident; and if a ſubſtance, whether corporeal or immaterial: nor is it clearly contained in this definition, that nature does all things moſt wiſely, and ſtill acts by the moſt compendious ways without ever miſſing of her end; and that ſhe watches againſt a vacuum for the welfare of the univerſe; to omit divers other things, that you will find aſcribed to her in the following ſection, to which I now proceed.

That the great ſhortneſs of this third ſection may not make it too diſproportionate in length to the others this tract conſiſts of, I ſhall in this place, though I doubt it be not the moſt proper, that could be choſen, endeavour to remove betimes the prejudice, that ſome divines and other pious men may perhaps entertain, upon the account, as they think, of religion, againſt the care I take, to decline the frequent uſe of that word nature, in the vulgar notion of it; reſerving to another and fitter place ſome other things, that may relate to the theological ſcruples, if any occur to me, that our free inquiry may occaſion.

The philoſophical reaſon, that inclines me to forbear, as much as conveniently I can, the frequent uſe of the word nature, and the forms of ſpeech, that are derived from it is, that it is a term of great ambiguity: on which ſcore I have obſerved, that, being frequently and unwarily employed, it has occaſioned much darkneſs and confuſion in many men's writings and diſcourſes. And I little doubt, but that others would make the like obſervations, if early prejudices and univerſal cuſtom did not keep them from taking notice of it.

Nor do I think myſelf obliged, by the juſt veneration I owe and pay religion, to make uſe of a term ſo inconvenient to philoſophy. For I do not find, that for many ages the *Iſraelites*, that then were the only people and church of God, made uſe of the word nature in the vulgar notion of it. *Moſes* in the whole hiſtory of the creation, where it had been ſo proper to bring in this firſt of ſecond cauſes, has not a word of nature: and whereas philoſophers preſume, that ſhe, by her plaſtic power and ſkill, forms plants and animals out of the univerſal matter, the divine hiſtorian aſcribes the formation of them to God's immediate *fiat*, *Gen.* i. 11. *And God ſaid, let the earth bring forth graſs, and the herb yielding ſeed, and the fruit tree yielding fruit after his kind*, &c. And again, *ver.* 24. *God ſaid, let the earth bring forth the living creature after its kind*, &c. *ver.* 25. *And God* (without any mention of nature) *made the beaſt of the earth after his kind.* And I do not remember, that in the *Old Teſtament*, I have met with any one Hebrew word, that properly ſignifies nature, in the ſenſe we take it in. And it ſeems, that our Engliſh tranſlators of the Bible were not more fortunate in that, than I; for having purpoſely conſulted a late concordance, I found not that word nature in any text of the *Old Teſtament*. So likewiſe, though *Job*, *David*, and *Solomon*, and other *Iſraelitiſh* writers, do, on divers occaſions, many times mention the corporeal works of God, yet they do not take notice of nature, which our philoſophers would have his great vicegerent in what relates to them. To which perhaps it may not be impertinent to add, that though the late famous *Rabbi Menaſſeh Ben Iſrael* has purpoſely written a a book of numerous problems touching the creation; yet I do not remember, that he employs the word nature, in the received notion of it, to give an account of God's mundane creatures. And when St. *Paul* himſelf, who was no ſtranger to the Heathen learning, writing to the *Corinthians*, who were *Greeks*, ſpeaks of the production of corn out of ſeed ſown, he does not attribute the produced body to nature; but when he had ſpoken of a *grain of wheat, or ſome other ſeed* put into the ground; he adds, that *God gives it ſuch a body as he pleaſeth, and to every ſeed its own body*, i. e. And a greater than St. *Paul*, ſpeaking of the gaudineſs of the lillies, (or as ſome will have it, tulips,) uſes this expreſſion, *If God ſo clothe the graſs of the field*, &c. *Matt.* vi. 28, 29, 30. The celebrations, that *David*, *Job*, and other holy *Hebrews*, mentioned in the *Old Teſtament*, make on occaſion of the admirable works they contemplated in the univerſe, are addreſſed directly to God himſelf, without taking notice of nature. Of this I could multiply inſtances, but ſhall here, for brevity's ſake, be contented to name a few, taken from the book of *Pſalms* alone. In the hundredth of thoſe hymns, the penman of it makes this, *That*

1 Cor. xv. 37, 38.

God has made us, the ground of an exhortation, *To enter into his gates with thankſgiving, and into his courts with praiſe*, Pſal. lxxix. 34. And in another, *Let the heaven and earth praiſe God*, [that is, give men ground and occaſion to praiſe Him] congruouſly to what *David* elſewhere ſays to the great creator of the univerſe, *All thy works ſhall praiſe thee, O Lord, and thy ſaints ſhall bleſs thee*, Pſal. cxlv. 10. And in another of the ſacred hymns, the ſame royal poet ſays to his maker, *Thou haſt covered me in my mother's womb. I will praiſe thee, for I am fearfully and wonderfully made, marvellous are thy works, and that my ſoul knoweth right well*, Pſal. cxxxix. 13, 14.

I HAVE ſometimes doubted, whether one may not on this occaſion add, that if men will needs take in a Being ſubordinate to God, for the management of the world; it ſeems more conſonant to the holy ſcripture, to depute angels to that charge, than nature. For I conſider, that, as to the cœleſtial part of the univerſe, in compariſon of which the ſublunary is not perhaps the ten thouſandth part, both the heathen *Ariſtotelians*, and the ſchool philoſophers among the Chriſtians, teach the cœleſtial orbs to be moved or guided by intelligences, or angels. And as to the lower or ſublunary world, beſides that the holy writings teach us, that angels have been often employed by God for the government of kingdoms, (as is evident out of the book of *Daniel*) and the welfare and puniſhment of particular perſons; one of thoſe glorious ſpirits is, in the apocalypſe, expreſsly Rev. xvi. 5. ſtyled *the angel of the waters*: which title divers learned interpreters think to be given him, becauſe of his charge or office to overſee and preſerve the waters. And I remember, that in the ſame book there is mention made of an angel, that had *power, authority*, or *juriſdiction*, Rev. xiv. 18. (ἐξουσία) *over the fire*. And though the excellent *Grotius* gives another conjecture of the title given the *angel of the waters*; yet in his notes upon the next verſe ſave one, he teaches, that there was an angel appointed to preſerve the ſouls, that were kept under the altar there mentioned. And if we Verſe 7. take the *angel of the waters* to be the guardian or conſerver of them, perhaps as the *Romans* (in whoſe empire St. *John* wrote) had ſpecial officers to look to their aqueducts and other waters; it may not be amiſs to obſerve upon the by, that he is introduced praiſing his and his fellow-ſpirits great creator: which is an act of religion, that, for aught I know, none of the naturiſts, whether Pagan or even Chriſtians, ever mentioned their nature to have performed.

I KNOW it may on this occaſion be alledged, that *ſubordinata non pugnant*, and nature being God's vicegerent, her works are indeed his. But that he has ſuch a vicegerent, it is one of the main buſineſſes of this diſcourſe to call in queſtion; and till the affirmative be ſolidly proved, (nay, and though it were ſo) I hope I ſhall be excuſed, if with *Moſes*, *Job*, and *David*, I call the creatures I admire in the viſible world, the works of God, (not of nature) and praiſe rather him than her, for the wiſdom and goodneſs diſplayed in them; ſince among the *Iſraelites*, till they were over-run and corrupted by idolatrous nations, there was for many ages a deep ſilence of ſuch a being, as we now call nature. And I think it much more ſafe and fit, to ſpeak as did thoſe, who for ſo long a time were the peculiar people of God, than with the heathen poets and philoſophers, who were very prone to aſcribe divinity to his creatures, and ſometimes even to their own.

I MENTION theſe things, not with deſign to engage in the controverſy, about the authority or uſe of the ſcripture in phyſical ſpeculations, but to obviate or remove a prejudice, that (as I formerly intimated) I fear may be taken up, upon the account of theology or religion, againſt my ſtudiouſly unfrequent employing the word nature in the vulgar ſenſe of it; by ſhewing, that, whether or no the ſcriptures be not deſigned to teach us higher and more neceſſary truths than thoſe, that concern bodies, and are diſcoverable by the meer light of reaſon, both its expreſſions and its ſilence give more countenance to our hypotheſis, than to that of the naturiſts.

SECT. IV.

III. HAVING ſhewn, that the definition given of nature by *Ariſtotle* himſelf, as great a logician as he was, has not been able to ſatiſfy ſo much as his interpreters and diſciples, what his own idea of nature was, it would be to little purpoſe to trouble you and myſelf with inquiring into the definitions and diſputes of other Peripatetics, about ſo obſcure and perplexed a ſubject; eſpecially ſince it is not my buſineſs in this tract ſolicitouſly to examine, what *Ariſtotle* thought nature to be, but what is to be thought of the vulgarly received notion of nature: and though of this the ſchools have been the chief propagators, for which reaſon it was fit to take notice of their maſter *Ariſtotle*'s definition; yet the beſt way, I know, to inveſtigate the commonly received opinion of nature, is, to conſider, what effata or axioms do paſs for current about her; and what titles and epithets are unanimouſly given her, both by philoſophers and other writers, and by the generality of men, that have occaſion to diſcourſe of her and her actings.

OF theſe axioms and epithets, the principal ſeen to be theſe, that follow.

Natura eſt ſapientiſſima, adeoque opus naturæ eſt opus intelligentiæ.

* *Natura nihil facit fruſtra.*

Natura fine ſuo nunquam excidit.

† *Natura ſemper facit quod optimum eſt.*

Natura ſemper agit per vias breviſſimas.

Natura neque redundat in ſuperfluis, neque deficit in neceſſariis.

Omnis natura eſt conſervatrix ſui.

Natura eſt morborum medicatrix.

* *Ariſt.* de Cœlo, *l.* II. c. 11.

† *Ariſt.* de Cœlo *l.* II. c. 5. it. de Gen. *l.* II. *c.* 10. § 22.

Natura ſemper invigilat conſervationi univerſi.

Natura vacuum horret.

From all theſe particulars put together, it may appear, that the vulgar notion of nature may be conveniently enough expreſſed by ſome ſuch deſcription as this:

Nature is a moſt wiſe being, that does nothing in vain; does not miſs of her ends; does always that, which (of the things ſhe can do) is beſt to be done; and this ſhe does by the moſt direct or compendious ways, neither employing any things ſuperfluous, nor being wanting in things neceſſary; ſhe teaches and inclines every one of her works to preſerve itſelf: and, as in the microcoſm, (man) it is ſhe, that is the curer of diſeaſes; ſo in the macrocoſm (the world) for the conſervation of the univerſe, ſhe abhors a vacuum, making particular bodies act contrary to their own inclinations and intereſts, to prevent it, for the public good.

What I think of the particulars, that make up this panegyrical deſcription of nature, will (God permitting) be told you in due place; my preſent work being only to make you the cleareſt repreſentation I can, of what men generally (if they underſtand themſelves) do, or, with congruity to the axioms they admit and uſe, ought to conceive nature to be.

It is not unlike, that you may expect or wiſh, that on this occaſion, I ſhould propoſe ſome definition or deſcription of nature, as my own. But declining (at leaſt at preſent) to ſay any thing dogmatically about this matter, I know not, whether I may not, on this occaſion, confeſs to you, that I have ſometimes been ſo paradoxical, or (if you pleaſe) ſo extravagant, as to entertain, as a ſerious doubt, what I formerly intimated, *viz.* whether nature be a thing, or a name? I mean, whether it be a real exiſtent being, or a notional entity, ſomewhat of kin to thoſe fictitious terms, that men have deviſed, that they might compendiouſly expreſs ſeveral things together by one name? as when, for inſtance, we ſpeak of the concocting faculty aſcribed to animals, thoſe, that conſider, and are careful to underſtand what they ſay, do not mean, I know not what entity, that is diſtinct from the human body, as it is an engine curiouſly contrived, and made up of ſtable and fluid parts; but obſerving an actuating power and fitneſs in the teeth, tongue, ſpittle, fibres and membranes of the gullet and ſtomach, together with the natural heat, the ferment, or elſe the menſtruum, and ſome other agents, by their co-operation, to cook or dreſs the aliments, and change them into chyle; obſerving theſe things, I ſay, they thought it convenient, for brevity's ſake, to expreſs the complex of thoſe cauſes, and the train of their actions, by the ſummary appellation of concocting faculty.

Whilst I was indulging myſelf in this kind of ravings, it came into my mind, that the naturiſts might demand of me, how, without admitting their notion, I could give any tolerable account of thoſe moſt uſeful forms of ſpeech, which men employ, when they ſay, that nature does this or that; or, that ſuch a thing is done by nature, or according to nature, or elſe happens againſt nature? and this queſtion I thought the more worth anſwering, becauſe theſe phraſes are ſo frequently uſed by men of all ſorts, as well learned as illiterate, that this cuſtom hath made them be thought not only very convenient, but neceſſary; inſomuch that I look upon it as none of the leaſt things, that has procured ſo general a reception to the vulgar notion of nature, that theſe ready and commodious forms of ſpeech ſuppoſe the truth of it.

It may therefore, in this place, be pertinent to add, that ſuch phraſes, as, that nature, or faculty, or ſuction, doth this or that, are not the only ones, wherein I obſerve, that men aſcribe to a notional thing that, which, indeed, is performed by real agents; as, when we ſay, that the law puniſhes murder with death, that it protects the innocent, releaſes a debtor out of priſon, when he has ſatiſfied his creditors (and the miniſters of juſtice) on which, or the like occaſions, we may juſtly ſay, that it is plain, that the law, which, being in itſelf a dead letter, is but a notional rule, cannot, in a phyſical ſenſe, be ſaid to perform theſe things; but they are really performed by judges, officers, executioners, and other men, acting according to that rule. Thus when we ſay, that cuſtom does this or that, we ought to mean only, that ſuch things are done by proper agents, acting with conformity to what is uſual, (or cuſtomary) on ſuch occaſions. And, to give you a yet more appoſite inſtance, do but conſider, how many events are wont to be aſcribed to fortune or chance; and yet fortune is, in reality, no phyſical cauſe of any thing, (for which reaſon probably it is, that antienter naturaliſts than *Ariſtotle*, as himſelf intimates, take no notice of it, when they treat of natural cauſes) and only denotes, that thoſe effects, that are aſcribed to it, were produced by their true and proper agents, without intending to produce them; as, when a man ſhoots at a deer, and the arrow lightly glancing upon the beaſt wounds ſome man, that lay beyond him, unſeen by the archer; it is plain, that the arrow is a phyſical agent, that acts by virtue of its fabrick and motion, in both theſe effects; and yet men will ſay, that the ſlight hurt it gave the deer, was brought to paſs according to the courſe of nature, becauſe the archer deſigned to ſhoot the beaſt; but the mortal wound it gave the man, happened by chance, becauſe the archer intended not to ſhoot him, or any man elſe. And whereas divers of the old atomical philoſophers, pretending (without good reaſon, as well as againſt piety) to give an account of the origin of things, without recourſe to a Deity, did ſometimes affirm the world to have been made by nature, and ſometimes by fortune, promiſcuouſly employing thoſe terms; they did it, (if I gueſs aright) becauſe

cauſe they thought neither of them to denote any true and proper phyſical cauſe, but rather certain conceptions, that we men have of the manner of acting of true and proper agents. And therefore, when the Epicureans taught the world to have been made by chance, it is probable, that they did not look upon chance, as a true and architectonic cauſe of the ſyſtem of the world, but believed all things to have been made by the atoms, conſidered as their conventions and concretions into the ſun, ſtars, earth, and other bodies, were made without any deſign of conſtituting thoſe bodies.

Whilst this vein of framing paradoxes yet continued, I ventured to proceed ſo far, as to queſtion, whether one may not infer, from what has been ſaid, that the chief advantage a philoſopher receives from what men call nature, be not, that it affords them, on divers occaſions, a compendious way of expreſſing themſelves? ſince (thought I) to conſider things otherwiſe than in a popular way, when a man tells me, that nature does ſuch a thing, he does not really help me to underſtand, or to explicate, how it is done; for it ſeems manifeſt enough, that whatever is done in the world, at leaſt wherein the rational ſoul intervenes not, is really effected by corporeal cauſes and agents, acting in a world ſo framed as ours is, according to the laws of motion ſettled by the omniſcient Author of things.

When a man knows the contrivance of a watch or clock, by viewing the ſeveral pieces of it, and ſeeing how, when they are duly put together, the ſpring or weight ſets one of the wheels a working, and by that another, till by a fit conſecution of the motions of theſe and other parts, at length the index comes to point at the right hour of the day; the man, if he be wiſe, will be well enough ſatisfied with this knowledge of the cauſe of the propoſed effect, without troubling himſelf to examine, whether a notional philoſopher will call the time-meaſuring inſtrument an *ens per ſe*, or an *ens per accidens*? and whether it performs its operations by virtue of an internal principle, ſuch as the ſpring of it ought to be? or of an external one, ſuch as one may think the appended weight? And, as he, that cannot, by the mechanical affections of the parts of the univerſal matter, explicate a phænomenon, will not be much helped to underſtand, how the effect is produced, by being told, that nature did it: ſo, if he can explain it mechanically, he has no more need to think, or (unleſs for brevity's ſake) to ſay, that nature brought it to paſs, than he, that obſerves the motions of a clock, has to ſay, that it is not the engine, but it is art, that ſhews the hour; whereas, without conſidering that general and uninſtructive name, he ſufficiently underſtands, how the parts, that make up the engine, are determined by their conſtruction, and the ſeries of their motions, to produce the effect, that is brought to paſs.

When the lower end of a reed, being dipped, for inſtance, in milk or water, he that holds it, does cover the upper end with his lips, and fetches his breath, and hereupon the liquor flows into his mouth; we are told, that nature raiſeth it to prevent a vacuum, and this way of raiſing it, is called ſuction: but, when this is ſaid, the word nature does but furniſh us with a ſhort term, to expreſs a concourſe of ſeveral cauſes, and ſo does in other caſes, but what the word ſuction does in this; for neither the one, nor the other, helps us to conceive, how this ſeemingly ſpontaneous aſcenſion of a heavy liquor is effected; which they that know, that the outward air is a heavy fluid, and gravitates, or preſſes more upon the other parts of the liquor, than the air contained in the reed (which is rarefied by the dilatation of the ſucker's thorax) does upon the included part of the ſurface, will readily apprehend, that the ſmaller preſſure will be ſurmounted by the greater, and conſequently yield to the aſcenſion of the liquor, which is, by the prevalent external preſſure, impelled up into the pipe, and ſo into the mouth, (as I, among others, have elſewhere made out.) So that, according to this doctrine, without recurring to nature's care, to prevent a vacuum, one, that had never heard of the Peripatetick notions of nature, or of ſuction, might very well underſtand the mentioned phænomenon. And, if afterwards he ſhould be made acquainted with the received opinions, and forms of ſpeech, uſed on this occaſion, he would think, that ſo to aſcribe the effect to nature is needleſs, if not alſo erroneous; and that the common theory of ſuction can afford him nothing, but a compendious term, to expreſs, at once, the concourſe of the agents, that make the water aſcend.

How far, I think, theſe extravagant reaſonings may be admitted, you may be enabled to diſcern, by what you will hereafter meet with, relating to the ſame ſubjects, in the ſeventh ſection of this diſcourſe. And therefore, returning now to the riſe of this digreſſion, namely, that it is not unlike you may expect, I ſhould, after the vulgar notion of nature, that I lately mentioned, without acquieſcing in it, ſubſtitute ſome definition or deſcription of nature, as mine; I hope you will be pleaſed to remember, that the deſign of this paper was, to examine the vulgar notion of nature, not propoſe a new one of my own. And indeed the ambiguity of the word is ſo great, and it is, even by learned men, uſually employed to ſignify ſuch different things, that, without enumerating and diſtinguiſhing its various acceptions, it were very unſafe to give a definition of it, if not impoſſible to deliver one, that would not be liable to cenſure. I ſhall not therefore preſume to define a thing, of which there is yet no ſettled and ſtated notion agreed on among men: and yet, that I may, as far as I dare, comply with your curioſity,

rioſity, I ſhall tell you, that if I were to propoſe a notion, as leſs unfit, than any I have met with, to paſs for the principal notion of nature, with regard to which many axioms and expreſſions, relating to that word, may be not inconveniently underſtood, I ſhould diſtinguiſh between the univerſal, and the particular nature of things. And, of univerſal nature, the notion I would offer ſhould be ſome ſuch as this; that nature is the aggregate of the bodies, that make up the world, framed as it is, conſidered as a principle, by virtue whereof they act and ſuffer, according to the laws of motion preſcribed by the Author of things. Which deſcription may be thus paraphraſed; that nature, in general, is the reſult of the univerſal matter, or corporeal ſubſtance of the univerſe, conſidered as it is contrived in the preſent ſtructure and conſtitution of the world, whereby all the bodies, that compoſe it, are enabled to act upon, and fitted to ſuffer from one another, according to the ſettled laws of motion. I expect, that this deſcription will appear prolix, and require to be heedfully peruſed; but the intricateneſs and importance of the ſubject hindered me from making it ſhorter, and made me chuſe rather to preſume upon your attention, than not endeavour to expreſs myſelf intelligibly and warily about a ſubject of ſuch moment. And this will make way for the other (ſubordinate) notion, that is to attend the former deſcription; ſince the particular nature of an individual body conſiſts in the general nature, applied to a diſtinct portion of the univerſe; or rather ſuppoſing it to be placed, as it is, in a world, framed by God, like ours, it conſiſts in a convention of the mechanical affections (ſuch as bigneſs, figure, order, ſituation, contexture, and local motion) of its parts, (whether ſenſible or inſenſible) convenient and ſufficient to conſtitute in, or to intitle to, its particular ſpecies or denominations, the particular body they make up, as the concourſe of all theſe is conſidered as the principle of motion, reſt, and changes in that body.

If you will have me give to theſe two notions more compendious expreſſions, now that, by what hath been ſaid, I preſume you apprehend my meaning; I ſhall expreſs, what I called general nature, by coſmical mechaniſm, that is, a compriſal of all the mechanical affections (figure, ſize, motion, &c.) that belong to the matter of the great ſyſtem of the univerſe. And, to denote the nature of this or that particular body, I ſhall ſtyle it, the private, the particular, or (if you pleaſe) the individual mechaniſm of that body; or, for brevity's ſake, barely the mechaniſm of it, that is, the eſſential modification, if I may ſo ſpeak, by which I mean, the compriſal of all its mechanical affections convened in the particular body, conſidered, as it is determinately placed, in a world ſo conſtituted as ours is.

It is like you will think it ſtrange, that in this deſcription I ſhould make the preſent fabrick of the univerſe a part, as it were, of the notion I frame of nature, though the generality of philoſophers, as well as other men, ſpeak of her as a plaſtic principle of all the mundane bodies, as if they were her effects; and therefore they uſually call them the works of nature; and the changes, that are obſerved in them, the phaenomena of nature: but, for my part, I confeſs, I ſee no need to acknowledge any architectonic being, beſides God, antecedent to the firſt formation of the world.

The Peripateticks, whoſe ſchool either deviſed, or mainly propagated the received notion of nature, conceiving (not only matter, but) the world to be eternal, might look upon it, as the province, but could not, as the work of nature, which, in their hypotheſis, is its guardian, without having been its architect.

The Epicureans themſelves, that would refer all things, that are done in the world, to nature, cannot, according to their principles, make what they now call nature, to have been antecedent to the firſt formation of our preſent world: for, according to their hypotheſis, whilſt their numberleſs atoms wildly roved in their infinite vacuity, they had nothing belonging to them but bigneſs, figure and motion; and it was by the coalition or convention of theſe atoms, that the world had its beginning: ſo that, according to them, it was not nature, but chance, that framed the world; though afterwards, this original fabrick of things does, by virtue of its ſtructure, and the innate and unloſeable motive power of atoms, continue things in the ſame ſtate for the main; and this courſe, though caſually fallen into it, and continued without deſign, is that, which, according to their hypotheſis, ought to paſs for nature.

And, as meer reaſon doth not oblige me to acknowledge ſuch a nature, as we call in queſtion, antecedent to the origin of the world; ſo neither do I find, that any revelation contained in the holy ſcriptures, clearly teaches, that there was ſuch a being. For, in the hiſtory of the creation, it is expreſly ſaid, that *in the beginning God made the heavens and the earth*; and, in the whole account, that *Moſes* gives of the progreſs of it, there is not a word of the agency of nature; and, at the latter end, when God is introduced, as making a review of all the parts of the univerſe, it is ſaid, that *God ſaw* Gen. i. 31. *every thing that he had made*; and it is ſoon after added, that *he bleſſed and ſanctified the* Gen. ii. 3. *ſeventh day, becauſe, in it*, (or rather, *juſt before it*, as I find the *Hebrew* particle elſewhere uſed) *he had reſted from all his works, which God created and made*. And though there be a paſſage in the book of *Job*, that, Job xxxvii. 4, 6, 7. probably enough, argues the angels (there called the ſons of God) to have exiſted, either at the beginning of the firſt day's work, or ſome time before it; yet it is not there ſo much as intimated, that they were co-operators with their Maker, in the framing of the world, of which they are repreſented as ſpectators and applauders, but not ſo much as inſtruments. But ſince revelation, as much as I always reverence it, is, I confeſs, a foreign principle in this philoſophical inquiry, I ſhall wave it here, and tell you, that, when I conſult only the light of reaſon, I am inclined to apprehend the firſt formation of the world, after ſome ſuch manner as this:

I THINK it probable, (for I would not dogmatize on ſo weighty, and ſo difficult a ſubject) that the great and wiſe Author of things did, when he firſt formed the univerſal and undiſtinguiſhed matter into the world, put its parts into various motions, whereby they were neceſſarily divided into numberleſs portions of differing bulks, figures and ſituations, in reſpect of each other; and that, by his infinite wiſdom and power, he did ſo guide and over-rule the motions of theſe parts, at the beginning of things, as that (whether in a ſhorter or a longer time, reaſon cannot well determine) they were finally diſpoſed into that beautiful and orderly frame, we call the world; among whoſe parts ſome were ſo curiouſly contrived, as to be fit to become the ſeeds, or ſeminal principles of plants and animals. And I further conceive, that he ſettled ſuch laws or rules of local motion, among the parts of the univerſal matter, that, by his ordinary and preſerving concourſe, the ſeveral parts of the univerſe, thus once completed, ſhould be able to maintain the great conſtruction, or ſyſtem and œconomy of the mundane bodies, and propagate the ſpecies of living creatures. So that, according to this hypotheſis, I ſuppoſe no other efficient of the univerſe, but God himſelf, whoſe almighty power, ſtill accompanied with his infinite wiſdom, did at firſt frame the corporeal world, according to the divine ideas, which he had, as well moſt freely, as moſt wiſely determined to conform them to: for, I think, it is a miſtake to imagine, (as we are wont to do) that what is called the nature of this or that body, is wholly compriſed in its own matter, and its (I ſay not ſubſtantial, but) eſſential form; as if from that, or theſe only, all its operations muſt flow. For an individual body being but a part of the world, and encompaſſed with other parts of the ſame great automaton, needs the aſſiſtance or concourſe of other bodies, (which are external agents) to perform divers of its operations, and exhibit ſeveral phænomena that belong to it. This would quickly and manifeſtly appear, if, for inſtance, an animal or an herb could be removed into thoſe imaginary ſpaces the ſchool-men tell us of, beyond the world; or into ſuch a ſpace, as the Epicureans fancy their *intermundia*, or empty intervals, between thoſe numerous worlds, their maſter dreamed of: for, whatever the ſtructures of theſe living engines be, they would as little, without the co-operations of external agents, ſuch as the ſun, æther, air, &c. be able to exerciſe their functions, as the great mills, commonly uſed with us, would be to grind corn, without the aſſiſtance of wind or running water. Which may be thought the more credible, if it be conſidered, that by the mere excluſion of the air, (though not of light, or the earth's magnetical effluvia, &c.) procured by the air-pump, bodies placed in an extraordinary large glaſs, will preſently come into ſo differing a ſtate, that warm animals cannot live in it; nor flame (though of pure ſpirit of wine) burn; nor ſyringes draw up water, nor bees, or ſuch winged inſects fly; nor caterpillars crawl; nay, nor fire run along a train of dried gunpowder: all which I ſpeak upon my own experience. According to the foregoing hypotheſis, I conſider the frame of the world already made, as a great, and, if I may ſo ſpeak, pregnant automaton, that, like a woman with twins in her womb, or a ſhip furniſhed with pumps, ordnance, &c. is ſuch an engine, as compriſes, or conſiſts of ſeveral leſſer engines; and this compounded machine, in conjunction with the laws of motion, freely eſtabliſhed and ſtill maintained by God, among its parts, I look upon as a complex principle, whence reſults the ſettled order or courſe of things corporeal. And that which happens, according to this courſe, may, generally ſpeaking, be ſaid to come to paſs according to nature, or to be done by nature; and that, which thwarts this order, may be ſaid to be preternatural, or contrary to nature. And indeed, though men talk of nature as they pleaſe, yet whatever is done among things inanimate, which make incomparably the greateſt part of the univerſe, is really done but by particular bodies, acting on one another by local motion, modified by the other mechanical affections of the agent, of the patient, and of thoſe other bodies, that neceſſarily concur to the effect, or the phænomenon produced.

[*N. B.*] THOSE, that do not reliſh the knowledge of the opinions and rites of the antient *Jews* and *Heathens*, may paſs on to the next or fifth ſection, and ſkip the whole following excurſion, compriſed between double parathesſes's, which, though neither impertinent nor uſeleſs to the ſcope of this treatiſe, is not abſolutely neceſſary to it.

[IN the foregoing (third) ſection of this treatiſe, I hope I have given a ſufficient reaſon of my backwardneſs to make frequent uſe of the word nature; and now, in this (fourth) ſection, having laid down ſuch a deſcription of nature, as ſhews that her votaries repreſent her as a goddeſs, or at leaſt a ſemi-deity; it will not be improper, in this place, to declare ſome of the reaſons of my diſſatisfaction with the notion or thing itſelf, as well as with the uſe of the name; and to ſhew, why I am not willing to comply with thoſe many, that would impoſe it upon us as very friendly to religion.

AND theſe reaſons I ſhall the rather propoſe, becauſe not only the generality of other learned men, (as I juſt now intimated) but that of divines themſelves, for want of information, or for ſome other cauſe, ſeem not to have well conſidered ſo weighty a matter.

To manifeſt therefore the malevolent aſpect, that the vulgar notion of nature has had, and therefore poſſibly may have, on religion; I think fit, in a general way to premiſe, what things they are, which ſeem to me to have been the fundamental errors, that miſled the Heathen world, as well philoſophers as others: for, if I miſtake not, the looking upon meerly corporeal, and oftentimes inanimate things, as if they were endowed with life, ſenſe and underſtanding; and the aſcribing to nature, and ſome other beings, (whether real or imaginary) things, that belong but to God, have been ſome, (if not the chief) of the grand cauſes of the polytheiſm and idolatry of the gentiles.

THE moſt antient idolatry, (taking the word in its laxer ſenſe) or at leaſt one of the earlieſt, ſeems to have been the worſhip of the cœleſtial lights, eſpecially the ſun and moon; that kind of *Aboda zara*, עבדה צרה (as the Jewiſh writers call ſtrange or falſe worſhips) being the moſt natural, as having for its objects, glorious bodies, immortal, always regularly moved, and very beneficial to men. There is recorded, in the holy ſcripture, a paſſage of *Job*, who is probably reputed to be, at leaſt, as antient as *Moſes*, which ſeems to argue, that this worſhip, of the two great luminaries, was practiſed in his time, and looked upon as criminal by religious men; and, as our Engliſh verſion renders the Hebrew words, puniſhable by the civil magiſtrate. If, ſays *Job*, *I beheld the ſun, when it ſhined, or the moon walking in brightneſs: and my heart hath been ſecretly inticed, or my mouth hath kiſſed my hand*, &c. And that this idolatry was practiſed in *Moſes*'s time, may be gathered from that paſſage in Deuteronomy. *And leſt thou lift up thine eyes unto heaven, and when thou ſeeſt the ſun, and the moon, and the ſtars, even all the hoſt of heaven, ſhouldſt be driven to worſhip them, and ſerve them*, &c. The Sabeans, or, as many criticks call them, the Zabians, are, by ſome very learned men, thought to have been the earlieſt idolaters: and the ableſt of the Jewiſh Rabbies, *Maimonides*, makes them to be ſo antient, that *Abraham* was put to diſpute againſt them. And their ſuperſtition had ſo over-ſpread the Eaſt, in *Moſes*'s time, that the ſame *Maimonides* judiciouſly obſerves, that divers of the ceremonial laws, given to the *Jews*, were inſtituted in oppoſition to the idolatrous opinions, magical rites, and other ſuperſtitions of the Zabians. Of this he (ſeconded therein by our famous *Selden*) gives ſeveral inſtances; to which, ſome are added by the learned *Hottinger*. But this only upon the by; my purpoſe, in mentioning theſe Zabians, being to obſerve to you, that they looked upon the planets, and eſpecially the ſun and moon, as gods, and worſhipped them accordingly, taking them for intelligent beings, that had a great intereſt in the government of the world.

Job xxxi. 26, 27.

Deut. iv. 19.

More Nevoch. lib. 3. c. 30.

Hiſt. Orientalis lib. 1. cap. 8.

THIS may be proved out of ſome Eaſtern writers, eſpecially *Maimonides*, who, in one place, aſſerts the Zabians to have adored the ſun and moon, and the *hoſt of heaven*, (as the ſcripture ſtyles the cœleſtial lights) as true gods: and this we ſhall the leſs wonder at, if we conſult another place of the ſame learned author, wherein he informs the readers, that theſe idolaters (the Zabians or Chaldeans) made ſtatues of ſilver and gold, thoſe for the ſun, and theſe for the moon; which, being conſecrated by certain rites and ceremonies, did invite, and, as it were, attract the ſpirits of theſe ſtars into thoſe ſhrines; whence they would ſpeak to their worſhippers, acquaint them with things profitable, and even predict to them things to come. And of ſome ſuch ſort of ſpeaking images, ſome learned criticks ſuppoſe the *Teraphim* (as the original text calls them) to have been, that *Laban* ſo prized, as to call them his gods: which it is gueſſed *Rachel* ſtole from her father, leſt, by conſulting them, he might learn what way her huſband and his company had taken in their flight. And the ſame great Rabbi having informed his readers, that he ſaw ſeveral books of tht Zabian ſuperſtition, ſomewhere mentions one or two, that treated of ſpeaking-images. And it was perhaps from theſe Zabians, or their diſciples, that *Zeno*, the founder of the Stoical ſect, taught, as *Stobæus* informs us, that the ſun, moon, and the reſt of the ſtars were endowed with underſtanding and prudence. And *Seneca*, an eminent champion of that rigid ſect*, reprehends *Epicurus* and *Anaxagoras*, (whoſe diſciple he was, in that opinion) that they held the ſun to be a burning ſtone, or an aggregate of caſual fires, and any thing, rather than a god.

Lib. 3. cap. 36.

2 Kings xvii. 16. 2 Chron. xxxiii. 3.

Mor. Nevoch. lib. 3. *cap.* 25.

Gen. xxxI. xix. v. 30

* *Sen. de Benef. lib.* 7. c. 21.

I AM ſorry I could not avoid thinking the great *Hippocrates* to have been involved in the great error we are ſpeaking of, when in his book *De principiis aut carnibus*, near the beginning, I met with this paſſage; *Videtur ſane mihi id, quod* (Θερμὸν) *calidum vocamus, immortale eſſe, et cuncta intelligere et videre, et audire et ſcire omnia, tum præſentia tum futura.* According to which ſuppoſition, he preſently attempts to give ſome ſuch account of the origin of the world's frame, as he could in a very few lines; and then ſpends the reſt of the book, in giving particular accounts, how the parts of the human body come to be framed; wherein, though I commend the attempt in general, becauſe, without acquieſcing in I know not what faculties, he endeavours to give an intelligible and particular account, how things come to be performed and produced; yet I cannot but look on this book, as a remarkable inſtance of this truth, that, without having recourſe to the true God, a ſatisfactory account cannot be given of the original or primitive production of the greater and leſſer world, ſince ſo great a naturaliſt as *Hippocrates*, by the help of his his idolized Θερμὸν, was unable to perform this taſk, with any ſatisfaction to an attentive and intelligent inquirer. And *Galen* himſelf, who was not unacquainted with *Moſes*'s writings, and lived when Chriſtianity was propagated through a great part of the world; *Galen*, I ſay, even in that admirable treatiſe, *De uſu Partium*, where he ſo excellently declares and celebrates the moſt wiſe author of things, was ſo far tranſported with the error, which infected ſo many other heathen philoſophers, that he fancied the earth itſelf, though he ſpeaks contemptibly of it, had a certain ſoul or mind, imparted to it by the ſuperior bodies, which, he ſaith, is ſo conſpicuous, firſt in the ſun, then in the moon, and afterwards in the other ſtars; that by their beauty the contemplator will be induced to think it reaſonable, that the more pure their corporeal ſubſtance is, it is inhabited by a mind, ſo much the better and more perfect than that of theſe terreſtrial bodies. And having ſpoken of the reaſoning nature, that ſhined in *Plato*, *Ariſtotle*, *Hipparchus*, *Archimedes*, &c. he thus infers; *Si igitur in tanta colluvie (quo enim alio nomine quis appellet id, quod ex carne, ſanguine, pituita, ac bile utraque eſt conſtatum) mens gignatur, adeo eximia & excellens; quantam ejuſdem putandum eſt eſſe excellentiam in Sole, Luna, aliiſque etiam Sideribus?* (to which he ſubjoins) *Mihi quidem, dum hæc mecum voluto, non exigua quædam mens talis, per ipſum etiam nos aerem ambientem, eſſe extenſa videtur. Fieri enim non poteſt, quum lucis ipſius Solis ſit particeps, quin vim etiam ab ipſo aſſumat.*

Galenus de uſu Partium, l. xvii. apud Lacunam in Epitome Oper. Galeni.

BUT this upon the by. Nor did this opinion of the divinity of the cœleſtial bodies die with the *Zabians*, or the *Greek* philoſophers. For I found, by ſome queſtions I propoſed to an inquiſitive perſon, who, having lived many years in *China* and ſeveral of the neighbouring kingdoms, had acquired ſkill enough in the tongues to converſe with the natives; I found, I ſay, that in a ſolemn conference he had with ſome of the more eminent and philoſophical doctors of the *Chineſes* religion, they frankly profeſt, that they believe the heavenly bodies to be truly divine, and to be worſhipped, and that upon this particular ground, that they imparted to men ſuch good things, as light, heat, rain, *&c.* and the productions and conſequences of theſe: and this belief they declared, they thought more rational, than that of the *Europeans*, who worſhip a deity, whoſe neither ſhape, nor colour, nor motion, nor efficacy on ſublunary things, were at all viſible. It agrees very well with the opinion of the antient *Greeks*, who, as *Origen* relates, called the ſun, moon, and the ſtars ἐμφανεῖς Θεοὺς ϗ αἰσθητοὺς, *conſpicuous and ſenſible gods*. And we are taught by *Euſebius*, that the antient *Ægyptian* theologizers, whoſe religion was neer of kin to that of the *Chaldeans*, if not borrowed of it, looked upon the ſun and moon, whom they worſhipped under the names of *Oſiris* and *Iſis*, not only as the chief gods, but as the makers and governors of much, if not of all, of the reſt of the univerſe.

Origen. cont. *Celſum.* l. v.

Præparat. l. iii. c 4. Damaſcius vita Iſideri apud Photium: Colunt præ cœteris Diis Ægyptii

Oſirim & Iſin (*i. e.* Solem & Lunam,) illum omnia condere, & figuris numeriſque materiam adornare arbitrati.

I WILL not here inquire, whether theſe old heathen philoſophers did, beſides the ſtars and other beings, that they adored as gods, believe one only numen or ſupreme deity. But that may ſuffice for my preſent purpoſe, which ſeems manifeſt, *viz.* that they aſcribed to ſenſible beings, attributes peculiar to the true God; that this was occaſioned by their thinking them intelligent and governing; and that theſe inferior beings were, by far, the moſt uſual and familiar objects both of their diſcourſes and their worſhip; and that they did (to uſe the phraſe of the apoſtle of the *Gentiles*) worſhip the *creature beſides*, or *more than*, (for the *Greek* word παρὰ may ſignify either) the *Creator*, who by *Moſes*, the prophets, and the apoſtles, expreſly declares a diſlike of this worſhip, and even in that more ſpecious and ſeemingly excuſeable kind of it, which was in uſe among the ten tribes, that profeſſed, and perhaps believed, their worſhip to be directed to the one ſupreme God, and him the true God of *Iſrael*. But this alſo upon the by.

Rom. i. 25.

THIS belief, that the world, and divers of its principal parts, as the ſun, moon, ſtars, *&c.* were animated and endowed with intelligent minds, was ſo contagious, that, not only it helped to ſeduce the emperor *Julian* from Chriſtianity to heatheniſm, (inſomuch that he gives the ſun ſolemn thanks for his advancement to the *Roman* monarchy;) but it infected very learned men among the *Jews* and *Chriſtians*. Of the former, I ſhall need to name but two; the firſt being the famouſeſt and judiciouſeſt of the antienter *Rabbins*, *Maimonides*, in whom, I confeſs, I wondered to find this aſſertion, that the ſun and ſtars were animated beings, endowed with underſtanding and will: and the other, being reputed the chief and the moſt learned of the moderns, *Menaſſeh Ben Iſrael*, (with whom I have converſed at *Amſterdam*) who in his problems, *De creatione*, hath this notable paſſage.—*Quad de intelligentiis tradunt, id vero mera fabula eſt; nam Cæli, ſecundum Rabbi Moſem, & rei veritatem, habent animas proprias rationali vita præditas, ſicut alibi à me demonſtrabitur.* And a greater man than *Maimonides*, *Origen* himſelf, among the Chriſtians, not only in one place adventures to ſay, *Siquidem etiam Cæleſtes Stellæ Animalia ſunt Rationalia, virtute prædita, illuſtrata Cognitionis Lumine, à Sapientia illa, quæ eſt Splendor æterni Luminis*; but in another proceeds ſo far, that I found (not without ſurprize) that he ſays, *the Chriſtians ſing hymns to God the Lord of all, and God the word; no otherwiſe than do the ſun, moon, and ſtars, and the whole heavenly hoſt, ſince all theſe, being a heavenly choir, do with juſt men celebrate the ſupreme God, and his only begotten* [*Son.*] The boldneſs of theſe unjuſtified paradoxes I the leſs wonder at, when I conſider, what has for many ages been taught by the ſchool philoſophers, from *Ariſtotle*; namely, that the cœleſtial ſpheres had their peculiar intelligences, that is, rational, immortal, powerful and active Beings. It is true, that in the

Sed nec illam, quam ejuſdem Numinis (Solis) beneficio adeptus ſum, ſortem conditionemque parvi facio; quod ex eo genere, penes quod Terrarum Dominatus atque Imperium eſt, temporibus noſtris ortum acceperim. Julian. ad Regem Solem.

More Nevochim. l. iii. c.29. (ni fallor.) Pag. M. 98.

Origen. cont. *Celſum.* l. v.

Origen. cont. *Celſum.* l. viii.

Jews and *Chriſtians* I have been ſpeaking of, the malignity of the error they embraced was corrected and maſtered by the ſound and orthodox principles they held together with it. But ſtill it is dangerous for thoſe, that would be loyal to him, that ſtiles himſelf a *jealous God*, to adopt premiſes, that have been able to miſlead ſuch great perſons, and from which many famous philoſophers have plauſibly enough drawn conſequences very repugnant to true religion. Nor are Chriſtians themſelves ſo much out of danger of being ſeduced by theſe heatheniſh notions about an intelligent world, but that (not again to mention the apoſtate emperor) even in theſe times there is lately ſprung up a ſect of men, as well profeſſing Chriſtianity, as pretending to philoſophy, who (if I be not miſ-informed of their doctrine) do very much ſymbolize with the antient Heathens, and talk much indeed of God, but mean ſuch a one, as is not really diſtinct from the animated and intelligent univerſe; but is, on that account, very differing from the true God, that we Chriſtians believe and worſhip. And though I find the leaders of this ſect to be looked upon, by ſome more witty than knowing men, as the diſcoverers of unheard of myſteries in phyſics and natural theology; yet their hypotheſis does not at all appear to me to be new, eſpecially when I remember, beſides the paſſages of the antients, cited in this paper, ſome others of the ſame import, ſuch as is particularly that of *Lucan*.

Exod. xx.

Eſtque Dei ſedes, niſi Terra, & Pontus, & Aer,
Et Cælum, & Virtus? Superos quid quærimus ultra?
Jupiter eſt quodcunque vides, quocunque moveris.

The great affinity between the *ſoul of the world*, ſo much talked of among the heathen philoſophers, and the thing, that men call nature, makes it fit for me to take notice, in this place, of the influence, which the belief of that imaginary ſoul had upon the *Gentiles*, with reference to religion.

That divers of the antient philoſophers held the world to be animated, hath been obſerved by more than one learned man: but that, which makes more for my preſent purpoſe, is, that the ſame old ſages did alſo (at leaſt for the moſt part) believe, that this mundane ſoul was not barely a living, but a moſt intelligent and wiſely active Being. This may be eaſily enough diſcerned by him, that ſhall heedfully peruſe *Diogenes Laertius*'s lives of the philoſophers, and particularly of *Zeno*. But at preſent I ſhall rather make uſe of an author, who, though he be very ſeldom cited for philoſophical hiſtory, ſeems to me to have been very well verſed in it. The writer, I mean, is the acute ſceptic *Sextus Empiricus*, (who is thought to have lived about *Plutarch*'s time, and, by ſome, to have been his nephew;) who recites a long ratiocination of *Xenophon*, which, whether it be ſolid or not, is at leaſt ingenious and plauſible, but too prolix to be tranſcribed in this place, where we may ſuffice to ſay, that he thus concludes: *Eſt ergo Mundus mente præditus & Intelligens, &c.* which aſſertion *Sextus* himſelf thus propoſes for him; *Si non eſſet aliqua Mens in Mundo, neque ulla Mens in te eſſet. Eſt autem in te Mens aliqua; ergo eſt etiam in Mundo. Et Ideo Mundus eſt Mente & Intelligentia præditus.* The ſame ſceptic introduces *Zeno Cittieus* diſcourſing thus; *quod immittit ſemen ejus quod eſt particeps rationis, eſt ipſum quoque rationis particeps. Mundus autem emittit Semen ejus, quod eſt particeps rationis; eſt ergo Mundus rationis particeps.* To which teſtimonies I might add many others out of the ſame author, who, in the ſame diſcourſe, tells us, that the Stoicks held the world to be an animal. But the opinion, that the old philoſophers we have been ſpeaking of, held of the world's being endowed with an underſtanding or rational ſoul, will be yet more evident by what I now proceed to alledge, to manifeſt, how this opinion of theirs led them to the worſhip of another, than the true God.

Sextus Empir. adverſus Mathemat. l. viii.

Sextus Empiricus, in the lately cited diſcourſe of *Xenophon*, infers from the world's being an intelligent being, that it is alſo a divine one; for to the lately recited concluſion, *Eſt ergo Mundus mente præditus & intelligens,* he immediately ſubjoins this other, *Et ideo Deus.* And a little after, repeating their diſcourſe, that defended this argumentation of *Xenophon* againſt an objection, he concludes their reaſoning thus; *Ideo Mundus eſt Mente & Intelligentia præditus: Cum ſit autem Mente & Intelligentia præditus, eſt etiam Deus. Quemadmodum* (ſays alſo *Phurnutus* the philoſopher,) *nos anima gubernamur, ſic & Mundus animam habet, quæ vindicet illum ab interitu; & hæc vocatur Jupiter.* To which agrees that in *Cicero*'s Academic Queſtions; *Mundum eſſe ſapientem, & habere mentem, quæ ſeipſam fabricata ſit, & omnia moderatur, regat.* And the reaſoning of the *Stoicks* in St. *Auguſtine* is very clear to the ſame purpoſe; * *Dicunt* (ſaith he, ſpeaking of the embracers of that ſect) *omnia Sidera partes Jovis eſſe, & omnia vivere atque rationales animas habere, & ideo ſine controverſia Deos eſſe.* And *Socrates* is introduced by *Ariſtophanes*, as no leſs than invocating the air and the æther together, in theſe words.

P. M. 326.

O Rex, O Imperator, Aer vaſte, quæ Terram contines ſuſpenſam,
Nec non ſplendide Æther.

Which brings into my mind that plain confeſſion of the poet *Manilius*.

Qua pateat, Mundum divino Numine verti,
Atque ipſum eſſe Deum.

To all theſe I ſhall add that notable and expreſs paſſage of the elder *Pliny*; † *Mundum, & hoc quod alio nomine Cælum appellare libuit,*

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* Auguſt. de Civit. Dei. l. vii. c. 2.

† Natur. Hiſt. l. ii. c. 1.

cujus circumflexu teguntur omnia, Numen eſſe credi par eſt, æternum, immenſum, neque genitum, neque interiturum unquam. Sacer eſt, æternus, immenſus, totus in toto, vero ipſe totum, finitus & infinito ſimilis, extra, intra, cuncta complexus in ſe, idemque Naturæ opus, & rerum ipſa Natura.

IF it be objected, that the paſſages I have cited out of heathen philoſophers, concern the ſoul of the world, and not nature; I anſwer, that the affinity of theſe two is ſo great, that divers of the old ſages ſeem to have confounded them, and not to have made account of any other univerſal nature, than the ſoul of the world. And however, the great and pernicious errors they were led into by the belief, that the univerſe itſelf, and many of its nobler parts, beſides men, were endowed, not only with life, but underſtanding and providence, may ſuffice to make us Chriſtians very jealous of admitting ſuch a being, as that, which men venerate under the name of nature; ſince they aſcribe to it as many wonderful powers and prerogatives, as the Idolaters did to their adored mundane ſoul. But I ſhall give a further anſwer to the above propoſed objection, if I can ſhew, how ſacrilegiouſly they abuſed the being we are ſpeaking of, as well under the very name of nature, as under that of the ſoul of the world. On this occaſion I remember a paſſage in * *Seneca*, that I did not expect to meet with, where, ſpeaking of ſome ethnic opinions about thunder, *Non Jovem*, (ſays he) *qualem in Capitolio colimus, fulmina mittere, ſed cuſtodem rectoremque Univerſi, animam ac Spiritum Mundani hujus Operis Dominum & Artificem, cui nomen omne convenit*: to which, within a few lines after, he adds, *Vis illam Naturam vocare? Non peccabis, eſt enim, ex quo nata ſunt omnia, cujus Spiritu vivimus. Vis illam vocare Mundum? Non falleris, ipſe enim eſt totum quid, totus ſuis partibus inditus & ſe ſuſtinens vi ſua.* And the ſame author elſewhere, *Nihil* (ſays he) *Natura ſine Deo eſt, nec Deus ſine Natura, ſed idem eſt Uterque.* And in another of the *Roman* ſages we have this paſſage; *Natura eſt igitur, quæ continet Mundum omnem, eumque tuetur, & quidem non ſine ſenſu ac ratione.* And the opinion, not of a private philoſopher, but of the ſect of *Stoicks*, is thus delivered by *Lactantius*: *Iſti uno naturæ nomine res diverſiſſimas comprehenderunt, Deum & Mundum, Artificem & Opus, dicuntque alterum ſine altero nihil poſſe, tanquam Natura ſit Deus Mundo permiſtus. Nam interdum ſic confundunt, ut ſit Deus ipſa mens Mundi, & Mundus ſit Corpus Dei; quaſi vero ſimul eſſe cæperint Mundus & Deus.* And to let you ſee, that in this our free inquiry I do not, without cauſe, here and there ſtyle nature ſometimes a ſemi-deity, and ſometimes a goddeſs, and talk of ſome men's idolizing her; I ſhall here annex part of a hymn of *Orpheus*'s, addreſſed immediately to nature.

* Natur. Quæſt. l. ii. c. 45.

De Benef. l. 4. c. 7.

Lib. vii. Cap. 1.

Ὦ φυσὶ παμμήτειρα Θεὰ, &c.

which his interpreter thus renders into *Latin*;

O Natura omnium Mater Dea, artificioſa admodum Dea,
Suſcitatrix honorabilis, multa creans, Divina Regina,
Omnidomans, indomita gubernatrix, ubique ſplendens.

And after a few lines;

Ætheria, Tereſtris, & Marina Regina, &c.

I know *Ariſtotle*, and his commentators, do not ſo directly idolize nature, as did *Orpheus* (or whoever was the antient author of the hymns, that bear his name;) but yet I doubt they paſs further than they can juſtify, when they ſo freely and often aſſert, that *Natura eſt ſapientiſſima*, that *Opus Naturæ eſt opus Intelligentiæ*, that *Natura ſine ſuo nunquam excidit*, that *Natura ſemper quod optimum eſt facit*, (to which may be added other-like axioms;) and when they moſt commonly call the works of God the works of nature, and mention him and her together, not as a creator and a creature, but as two co-ordinate governors, like the two *Roman* conſuls; as when they ſay frequently, and without ſcruple, (what I find to have been firſt by *Ariſtotle* himſelf) that *Deus & Natura nihil faciunt fruſtra*; to which phraſe may agree that expreſſion of *Ovid*, where, ſpeaking of the Chaos, whilſt the bodies, that compoſed it, lay ſhuffled together, and were not yet packed, he ſays,

Hanc Deus & melior litem Natura diremit.

Deus & Natura nihil prorſus *faciunt* fruſtra. Ariſt. de Cœlo, lib. ii. cap. 5.

TO the recital of the irreligious errors of the antient Heathens, about the divinity of the world, and ſome of its principal parts, as the ſun, moon, ſtars, æther, &c. I ſhould add a redargution of them, if I thought it neceſſary, in this place, ſolemnly to refute opinions, ſome of which are altogether precarious, and others very improbable. Thoſe Greek and Latin philoſophers, that held the ſun to be a fire, were much at a loſs to find out fuel to maintain the flame. But thoſe *Zabians* and *Chaldeans*, that thought him endowed, not only with a living ſoul, but with underſtanding and will, muſt, if they had duly conſidered things, have been much more puzzled, to find not only food for ſo vaſt a body, (above 160 times bigger than the terraqueous globe) but to find in him the organs neceſſary to the preparation and digeſtion of that food, and to the other functions, that belong to animal nutrition. And if we admit the Carteſian hypotheſis, the way, whereby the ſun, fixed ſtars, and planets, are generated, will ſufficiently manifeſt them to be neither intelligent nor living bodies: and perhaps I could here propoſe a quite other hypotheſis, about the nature of the ſun, and the fuel of its fire, that may be countenanced by ſome phænomena and experiments, without making him other than an igneous, and altogether inanimate body, dy, whoſe flame needs to be repaired by fuel furniſhed to it nearer hand, than from the ſea or earth. But I purpoſely omit ſuch objections againſt the opinion I oppoſe, as, though drawn from the dictates of ſound philoſophy about the origine of things, may be queſtioned, without being to be cleared in few words. It is alſo without proof, that it is preſumed and aſſerted, that the cœleſtial bodies, newly mentioned, are endowed with underſtanding and prudence, eſpecially ſo, as to be able to know the particular conditions and tranſactions of men, and hear and grant the prayers of their worſhippers. And the moon, which was one of their principal deities, and by them preferred before all the other planets and ſtars, the ſun excepted, is ſo rude and mountainous a body, that it is a wonder, that ſpeculative men, who conſidered, how many, how various, and how noble functions belong to a ſenſitive ſoul, could think a lump or maſs of matter, ſo very remote from being fitly organized, ſhould be animated and governed by a true living and ſenſitive ſoul. I know, that both theſe deifiers of the cœleſtial globes, and alſo the heathen diſciples of *Ariſtotle*, beſides divers of the ſame mind even among the Chriſtians, ſay great and lofty things of the quinteſſential nature of the heavenly bodies, and their conſequent incorruptibility; of the regularity of their motions, and of their divine quality of light, that makes them refulgent; but the perſuaſion they had of this quinteſſential nature of the ſuperior part of the world, was not, if I gueſs aright, grounded upon any ſolid phyſical reaſon, but was entertained by them for its congruity to the opinion they had of the divinity of the cœleſtial bodies; of which *Ariſtotle* himſelf, eſpecially in his books *de Cœlo*, ſpeaks in ſuch a way, as hath not a little contributed, among his followers, to ſuch an exceſſive veneration for thoſe bodies, as is neither agreeable to true philoſophy, nor friendly to true religion. He himſelf takes notice, that the *Pythagoreans* held our earth to be one of the planets, and that it moved about the ſun, which they placed in the middle of the world. And ſince this hypotheſis of the earth's motion was in the laſt age revived by *Copernicus*, not only thoſe great men *Keplerus*, *Galileo*, and *Gaſſendus*, but moſt of the beſt modern aſtronomers, and beſides *des Cartes* and his ſect, many other naturaliſts have embraced this hypotheſis; which, indeed, is far more agreeable to the phænomena, not only than the doctrine of *Ariſtotle*, (who was plainly miſtaken about the order and conſiſtence of the heavens) but than the antient and generally received Ptolomaic ſyſtem. Now, ſuppoſing the terraqueous globe to be a planet, he, that conſiders, that it is but a round maſs of very heterogeneous ſubſtances, (as appears by the differing natures of its great conſtituent parts, land and ſea) whoſe ſurface is very rude and uneven, and its body opacous, unleſs as it happens to be enlightned by the ſun, moon, and ſtars, and ſo very inorganical for ſo much as nutrition, that it ſeems wholly unfit to be a living animal: I ſay, he, that conſiders ſuch things, will ſcarce be forward to aſcribe underſtanding and providence, much leſs a divine nature, to the other ſtars; as for inſtance, to the moon, which our beſt teleſcopes manifeſt to be a very craggy and mountainous body, conſiſting of parts of very differing textures, (as appears by her brighter parts and permanent ſpots) and which of herſelf is opacous, having no manifeſt light, but what ſhe borrows from the ſun, and perhaps from the earth.

L. xi. c. 3.

Ariſtot. de Cœlo. l. xi. c. 13.

As for the boaſted immutability of the heavenly bodies, beſides that it may be very probably called in queſtion by the phænomena of ſome (for I do not ſay every one) of the comets, that by their parallax were found to be above the moon, and conſequently in the cœleſtial region of the world; beſides this, I ſay, the incorruptibleneſs and immutability of the heavenly bodies is more than probably diſproveable by the ſudden and irregular generation, changes, and deſtruction, of the ſpots of the ſun; which are ſometimes ſo ſuddenly deſtroyed, that I remember in the year 1660, on the 8th of *May*, having left in the morning a ſpot, whoſe motions we had long obſerved through an excellent teleſcope, with an expectation, that it would laſt many days viſible to us, we were ſurprized to find, that, when we came to obſerve it again in the evening, it was quite diſſipated, though it ſeemed thick; and by comparing it to the ſun, we eſtimated the extent of its ſurface to be equal to that of all *Europe*. As to the conſtancy of the motions of the ſtars; if the earth, which we know to be inanimated, be a planet, it moves as conſtantly and regularly about the ſun, (in that, which they call the great orb,) as the other planets do, or as the moon doth about the earth. And I conſider, that though we ſhould ſuppoſe our globe not to be a planet, yet there would manifeſtly be a conſtant motion, and regular enough, of a great part of it; ſince (bating ſome anomalies, that ſhores, winds, and ſome other extrinſic things, occaſion,) there is a regular ebbing and flowing twice a day, and alſo ſpring-tides twice a month, of that vaſt aggregate of waters, the ocean; which perhaps is not inferior in bulk to the whole body of the moon, and whereof alſo vaſt tracts are ſometimes obſerved to ſhine.

And laſtly, whereas a great proof of the divinity of the ſtars is taken from their light; though I grant it to be the nobleſt of ſenſible qualities, yet I cannot think it a good proof of the divine, or very excellent, nature of bodies endowed with it, whether they be cœleſtial or not. For whereas the *Zabians* and *Chaldeans* conſidered and adored the planets, as the chief gods, our teleſcopes diſcover to us, that, except the ſun, (if he be one, rather than a fixed ſtar) they ſhine but by a borrowed light; inſomuch that *Venus*, as vividly luminous as it appears to the naked eye, is ſometimes ſeen (as I have beheld it) horned like the moon in no long time after her change. And at this rate alſo the earth, whether it be a planet or no, is a luminous body, being enlightened by the ſun; and poſſibly, as a body forty times bigger, communicates more light to the moon, than it receives from her, as is probably argued from the light ſeen on the ſurface of the moon in ſome of her eclipſes. And, though in the night, when the darkneſs hath widened the pupils of our eyes, and the moon ſhines with an unrivaled luſtre, ſhe ſeems exceeding bright, yet ſhe may be, for aught I know, more opacous than the ſolid part of the terreſtrial globe: for I remember, that I have more than once heedfully obſerved a ſmall cloud in the weſt, where the moon then was, about ſun-ſet; and comparing them together, the little cloud, as opacous and looſe a body as it was, reflected the light as ſtrongly to my eye, as did the moon, that ſeemed perhaps to be not far from it, both of them appearing like little whitiſh clouds, though afterwards, as the ſun deſcended lower and lower beneath the horizon, the moon grew more and more luminous. And, ſpeaking of light indefinitely, it is ſo far from arguing a divine nature in the bodies, that are endowed with it, whether, as the planets, by participation from an external illuminant, or as the ſun, from an internal principle; that a burned ſtone, witneſs that of Bolonia, will afford, in proportion to its bulk, incomparably more borrowed light, than one of the planets. And a light from its internal conſtitution may be found, not only in ſuch abject creatures as inſects, whether winged, as the cucupias of *Hiſpaniola*, or creeping, as our glow-worms; but alſo in bodies inanimate and corrupted, as in rotten wood, in ſtinking whitings, and divers other putrified fiſhes.

I cannot now ſtay to inquire, how the Zabians, and ſuch idolaters as they, could make out the connexion, ſymmetry, and ſubordination or dependance of the ſeveral parts of the world, compoſed of ſo many different and diſtant beings, endowed not only with animal ſouls, but with their diſſtinct and peculiar underſtandings and wills, and many of them alſo with divine nature. Nor ſhall I conſider, how ſtrange a monſter, rather than an animal and a deity, thoſe many heathen philoſophers and their adherents muſt make of the univerſe, who held it to be but one; and yet were of the paradoxical opinion, that (as hath been elſewhere noted) is roundly profeſſed by *Stobæus*, at the very beginning of his phyſical eclogues, Ζεὺς ἐστὶ, *&c. i. e. Jupiter (quidem) totus mundus eſt: animal ex animalibus; numen ex numinibus compoſitum.*

THESE, I ſay, and the like objections againſt the pagan doctrine, I muſt not now inſiſt on, becauſe I perceive, that I have ſlipped into a ſomewhat long digreſſion, (which yet perhaps may not be altogether unſeaſonable or uſeleſs;) which therefore I ſhall here break off, to reſume and conclude the diſcourſe, that this ſection was allotted to, which I might eaſily have enlarged, but I preſume there is enough ſaid in it already, to let you ſee, that it is a dangerous thing to believe other creatures, than angels and men, to be intelligent and rational; eſpecially to aſcribe to any of them an architectonic, provident, and governing power. And though I readily acknowledge, that there is no great danger, that well inſtructed Chriſtians ſhould, like ſome Heathens, worſhip nature as a Goddeſs; yet the things I formerly alledged, to ſhew it unſafe to cheriſh opinions of kin to thoſe, that miſ-led a multitude even of philoſophers, make me fear too many, and not a few of the learned themſelves, may have a veneration for what they call nature, much greater than belongs to a meer creature; if they do not, to uſe a ſcripture expreſſion, *worſhip the creature, above* or *beſides* the *creator*, who, and not the world, nor the ſoul of it, is the true God. Rom. 1. 25. And though I ſhould grant, that the received notion of nature doth neither ſubvert, nor much endanger any principle of religion; yet that is not enough for the purpoſe of thoſe naturiſts I reaſon with; ſince they are here ſuppoſed to make it a fault in others, not to aſcribe to the nature they venerate, as much as themſelves do; and they repreſent their own notion of it, not only as innocent, but as very uſeful, if not neceſſary to religion.]

SECT. V.

IV. I COME now, *Eleutherius*, to acquaint you with ſome of the reaſons, that have made me backward to entertain ſuch a notion of nature, as I have hitherto diſcourſed of; and I ſhall at preſent compriſe them under the following five.

I. THE firſt whereof is, that ſuch a nature, as we are ſpeaking of, ſeems to me to be either aſſerted, or aſſumed without ſufficient proof. And this ſingle reaſon, if it be well made out, may, I think, ſuffice for my turn. For, in matters of philoſophy, where we ought not to take up any thing upon truſt, or believe it without proof, it is enough to keep us from believing a thing, that we have no poſitive argument to induce us to aſſent to it, though we have no particular arguments againſt it. And if this rule be to take place in leſſer caſes, ſure it ought to hold in this, where we are to entertain the belief of ſo catholick an agent, that all the others are looked upon but as its inſtruments, that act in ſubordination to it; and which, being ſaid to have an immediate agency in many of the phænomena of the world, cannot but be ſuppoſed to be demonſtrable by divers of them. I have yet met with no phyſical arguments, either demonſtrative, or ſo much as conſiderably probable, to evince the exiſtence of the nature we examine. And, though I ſhould admit the uſe, that ſome divines contend for, of the holy ſcriptures in philoſophical controverſies; yet I ſhould not be perſuaded of the exiſtence of the nature, we diſpute of: for I do not remember, that the ſcripture any where declares to us, that there is ſuch a thing, (in the ſenſe by me queſtioned) though (as I formerly noted more fully in the IV. ſection,) in *Geneſis* and ſome other places, where the corporeal works of God are expreſly treated of, (though in order to ſpiritual ends) one might probably enough expect to find ſome mention of God's grand vicegerent in the univerſe of bodies, if he had eſtabliſhed any ſuch. But whatever be the true cauſe of the ſcripture's ſilence about this matter, the ſilence itſelf is ſufficient to juſtify me for examining freely by reaſon a thing, that is not impoſed on my belief by revelation. And as for the phyſical arguments, that may be brought in favour of the queſtioned notion of nature, I ſhall, e'er long, examine the principal of them, and ſhew, that they are not convincing. To theſe things may be added, as to the proof drawn from the general opinion about nature, that being a popular, not a phyſical argument, it may indeed paſs for current with the vulgar, but ought not to do ſo with philoſophers.

II. The ſecond reaſon is taken from the unneceſſarineſs of ſuch a nature, as is pretended: for, ſince a great part of the work of true philoſophers has been, to reduce the true principles of things to the ſmalleſt number they can, without making them inſufficient; I ſee not, why we ſhould take in a principle, of which we have no need. For ſuppoſing the common matter of all bodies to have been at firſt divided into innumerable minute parts, by the wiſe author of nature, and theſe parts to have been ſo diſpoſed of, as to form the world, conſtituted as it now is; and eſpecially, ſuppoſing, that the univerſal laws of motion, among the parts of the matter, have been eſtabliſhed, and ſeveral conventions of particles contrived into the ſeminal principles of various things; all which may be effected by the mere local motion of matter, (not left to itſelf, but ſkilfully guided at the beginning of the world) if (I ſay) we ſuppoſe theſe things, together with God's ordinary and general concourſe, which we very reaſonably may; I ſee not, why the ſame phænomena, that we now obſerve in the world, ſhould not be produced, without taking in any ſuch powerful and intelligent being, diſtinct from God, as nature is repreſented to be. And, till I ſee ſome inſtance produced to the contrary, I am like to continue of this mind, and to think, that the phænomena, we obſerve, will genuinely follow from the mere fabrick and conſtitution of the world: as, ſuppoſing the ſun and moon to have been put, at firſt, into ſuch motions about the earth, as experience ſhews they have, the determinate celerity of theſe motions, and the lines, wherein they are performed, will make it neceſſary, that the moon ſhould be ſometimes full, ſometimes ſcarce illuminated at all to us-ward, ſometimes horned, and, in a word, ſhould exhibit ſuch ſeveral phaſes, as every month ſhe doth, and that, at ſometimes, ſhe and the ſun ſhould have a trine, or a quadrate aſpect, *&c.* and that now one, and now the other of them, ſhould, at ſet times, ſuffer an eclipſe; though theſe eclipſes were, by the Romans, and others of old, and are by many unlearned nations at this day, looked upon as ſupernatural things; and though alſo *Ariſtotle*, and a multitude of his followers, fancied, that ſuch regular motions could not be maintained without an aſſiſtent intelligence, which he and they therefore aſſigned to each of the heavenly orbs. And indeed the difficulty we find to conceive, how ſo great a fabrick, as the world, can be preſerved in order, and kept from running again to a chaos, ſeems to ariſe from hence; that men do not ſufficiently conſider the unſearchable wiſdom of the divine architect, or Δημιουργὸς (as the ſcripture ſtyles him) of the world, whoſe piercing eyes were able to look, at once, quite through the univerſe, and take into his proſpect both the beginning and end of time: ſo that perfectly fore-knowing, what would be the conſequences of all the poſſible conjunctures of circumſtances, into which matter, divided and moved according to ſuch laws, could, in an automaton ſo conſtituted as the preſent world is, happen to be put; there can nothing fall out, unleſs when a miracle is wrought, that ſhall be able to alter the courſe of things, or prejudice the conſtitution of them, any further, than he did from the beginning foreſee, and think fit to allow.

Heb. xi. 10.

Nor am I ſure, that the received notion of nature, though it be not neceſſary, is at leaſt very uſeful, to explicate phyſical phænomena: for beſides that I ſhall ſhew e'er long, that ſeveral explications, where recourſe to it is preſumed to be the moſt advantageous, are not to be allowed; to give the nature of a thing for the cauſe of this or that particular quality, or operation of it, is to leave men as ignorant as they were before; or, at leaſt, is to acknowledge, that a philoſopher can, in ſuch caſes, aſſign no better particular and immediate cauſes of things, than a ſhepherd or a tradeſman, that never learned natural philoſophy, can aſſign of the ſame things, and of a thouſand others. And though it be true, (as I formerly alſo intimated) that, in many caſes, philoſophers themſelves can anſwer no otherwiſe to ſuch queſtions, as may be propoſed to them, than by having recourſe to the nature of the thing; yet ſuch anſwerers do not declare the proper cauſe of a dark phænomenon, but only that he, who employs them, does not yet know it: and ſo this indefinite notion of nature, which is equally applicable to the reſolving of all difficulties, is not uſeful to diſcloſe the thing, but to delude the maker of the queſtion, or hide the ignorance of the anſwerer.

III. My third argument is, that the nature, I queſtion, is ſo dark and odd a thing, that it is hard to know what to make of it, it being ſcarce, if at all, intelligibly propoſed by them, that lay moſt weight upon it.

For it appears not clearly, whether they will have it to be a corporeal ſubſtance, or an immaterial one, or ſome ſuch thing, as may ſeem to be betwixt both; ſuch as many Peripateticks do repreſent ſubſtantial forms, and what they call real qualities, which divers ſchool-men hold to be (at leaſt by miracle) ſeparable from all matter whatſoever. If it be merely corporeal, I confeſs I underſtand not, how it can be ſo wiſe, and almoſt omniſcient an agent, as they would have it paſs for: beſides that if it be a body, I would gladly know, what kind of body it is; and how, ſince, among bodies, there can be no penetration of dimenſions, this body can ſo intimately pervade, as they pretend nature does all the other bodies of the world? And to this I would add divers other queſtions, that would not be eaſily anſwered: (but I ſhall reſume this third argument in another place.) If it be ſaid, that nature is a ſemi-ſubſtantia, as ſome of the moderneſt ſchool-men are pleaſed to call ſubſtantial forms and real qualities; I roundly anſwer, that I acknowledge no ſuch chimerical and unintelligible beings, and ſhall only deſire you to apply to them a good part of the diſcourſe, made in certain papers, occaſioned by a chymico-phyſical eſſay about ſalt-petre, againſt the pretended origin, and inexplicable nature of the imaginary ſubſtantial forms of the Peripateticks. It remains therefore, that this nature, we ſpeak of, if it be any thing poſitive, ſhould be an immaterial ſubſtance: but to have recourſe to ſuch an one, as a phyſical agent, and not only a determiner, but the grand author of the motion of bodies, and that, eſpecially, in ſuch familiar phænomena, as the aſcenſion of water in pumps, the ſuſpenſion of it in water-pots for gardens, the running of it through ſiphons, and I know not how many others, and to explain its caſuality, as they ſpeak, will I think, prove a work exceeding difficult: though I ſhall not here ſpend time to ſhew the farther inconveniences of ſuch a ſuppoſition, being to do that hereafter; and, in the mean-while, contenting myſelf to obſerve, as to many of the naturiſts, that though their doctrine may favour it, they ſeem rather content to talk darkly, and uncertainly, of what they call nature, than by clearly defining it, expoſe it to objections not eaſy to be anſwered, and who foreſee the advantage, that the unſettledneſs of the notion gives them, to pretend knowledge, or diſguiſe ignorance.

IV. SINCE many of the moſt learned amongſt the naturiſts are Chriſtians, and not few of them divines too, it may not be improper (which elſe I ſhould, perhaps, think it would be) to add, in this place, that the next thing, for which I diſlike the vulgar notion (or idea) of nature, is, that I think it dangerous to religion in general, and conſequently to the Chriſtian.

FOR this erroneous conceit defrauds the true God of divers acts of veneration and gratitude, that are due to him from men, upon the account of the viſible world, and diverts them to that imaginary being they call nature, which has no title to them; for whilſt nature is ſuppoſed to be an intelligent thing, that wiſely and benignly adminiſters all, that is done among bodies, it is no wonder that the generality of philoſophers, and, after their example, of other men, ſhould admire and praiſe her, for the wonderful, and for the uſeful things, that they obſerve in the world. And, in effect, though nature, in that ſenſe of the word I am ſpeaking of, be never (that I remember) to be found in the ſacred writings; yet nothing is to be more frequently met with (and that adorned with titles and encomiums) in the books of philoſophers, than nature and her effects. And, if we conſider, that whatever has been ſaid by ſome, in excuſe of *Ariſtotle* himſelf, yet the generality of the Peripateticks, from whom the vulgar notion of nature is chiefly received, made the world to be eternal, and referred all the tranſactions among the bodies it contains, to what they called nature. Whence it will not be difficult to perceive, that, if they do not quite exclude God, yet, as they leave him no intereſt in the firſt formation of the univerſe, ſo they leave him but very little in the adminiſtration of the parts it conſiſts of, eſpecially the ſublunary ones: ſo that, inſtead of the true God, they have ſubſtituted for us a kind of a goddeſs, with the title of nature; which as they look upon as the immediate agent and director, in all excellent productions, ſo they aſcribe to her the praiſe and glory of them.

WHETHER this great error, in a point of ſuch importance, may not undermine the foundation of religion, I think it may not irrationally be ſuſpected: for, ſince the moſt general and efficacious argument, that has perſuaded philoſophers, and other men, that there is a God and a conſideration of the providence, is afforded by the viſible world, wherein ſo many operations and other things are obſerved, that are managed (or performed) with ſuch conduct and benignity, as cannot juſtly be aſcribed but to the wiſdom and goodneſs of a Deity; they, that aſcribe theſe things to mere nature, do much weaken the force of that argument, if they do not quite take away the neceſſity of acknowledging a Deity, by ſhewing, that, without any need of having recourſe to him, of the adminiſtration of the world, and of what is performed among things corporeal, an account may be given. Though when men are put upon conſidering the matter, and preſſed to declare themſelves more clearly, they are aſhamed to affirm, that God and nature are the ſame thing, and will confeſs, that ſhe is but his vicegerent; yet, in practiſe, their admiration and their praiſes are frequently given to nature, not to God: in like manner, as, though the ſun be the fountain of light, and the moon derives all hers from the ſun; yet the ſea, in its grand motions of ebbing and flowing, appears to reſpect the moon, and not the ſun: for thus the generality of men, though they will acknowledge, that nature is inferior and ſubordinate to God, do yet appear to regard her more than him.

To be ſhort, nature uſes to be ſo frequently recurred to, and is ſo magnified in the writings of phyſiologers, that the exceſſive veneration men have for nature, as it has made ſome philoſophers (as the Epicureans) deny God, ſo it is to be feared, that it makes many forget him: and, perhaps, a ſuſpicious perſon would venture to add, that, if other principles hindered not (as, I know, that in many, and, I think, that in moſt of the Chriſtian naturiſts they do) the erroneous idea of nature would, too often, be found to have a ſtrong tendency to ſhake, if not to ſubvert, the very foundations of all religion; miſleading thoſe, that are inclined to be its enemies, from over-looking the neceſſity of a God, to the queſtioning, if not to the denial of his exiſtence.

V. MY fifth and laſt argument is taken from hence; that I obſerve divers phænomena, which do not agree with the notion or repreſentation of nature, that I queſtion: for if indeed there were ſuch an intelligent, powerful, and vigilant being, as philoſophers are wont to deſcribe nature to be, divers things would not be done, which experience aſſures us are done.

AND here I ſhall, once for all, give an advertiſement, which I deſire may be called to mind, whenever there ſhall be occaſion, in the following part of this tract, which is this: that becauſe inanimate bodies are uſually more ſimple, or leſs compounded, and of a ſlighter and leſs complicated or curious contrivance, than animals or plants, I thought fit to chuſe moſt of the inſtances I employ, rather among lifeleſs bodies, whoſe ſtructure and qualities are more eaſy to be intelligibly and with brevity diſcourſed of, than among living creatures, whoſe textures being organical, are much more intricate and ſubtile. And this courſe I did not ſcruple to take, becauſe the celebrators of nature give her a province, or rather an empire, as large as the world, and will have her care and juriſdiction reach, as well to inanimate, as to living bodies; and accordingly moſt of the conſpicuous inſtances they alledge of her providence and power, are taken from bodies deſtitute of life; as when they tell us, that the aſcenſion of water in ſucking-pumps, and the ſuſtentation of it in gardeners watering-pots, are cauſed by nature's abhorrence of a vacuum: that heavy bodies (unhindered) fall to the ground in a perpendicular line, becauſe nature directs them the ſhorteſt way to the centre of the earth; and that bubbles riſe through the water, and flames aſcend in the air, becauſe nature directs the bodies to rejoin themſelves to their reſpective elements; to omit other inſtances of this ſort, that there will be occaſion to mention hereafter: till when, theſe may ſuffice to warrant my taking moſt of my inſtances from inanimate bodies; though I ſhall not confine myſelf to theſe, eſpecially when I ſhall come to anſwer objections, that are taken from living creatures.

THE foregoing advertiſement will be, I hope, found conducive to clear the way for my fifth argument, lately propoſed, which concludes, that if indeed there were ſuch a being, as nature is uſually repreſented to be, ſeveral things would be otherwiſe adminiſtred in the univerſe, than experience ſhews they are.

To enumerate all the particulars, that may be propoſed to make this good, would ſwell this diſcourſe much beyond the bulk, to which my haſte obliges me to confine it. But, to make you amends for the paucity of inſtances, I ſhall now name, by the kind of them; I ſhall propoſe ſuch, as, for the moſt part, are taken from thoſe very things, whence the wiſdom and vigilancy of nature is wont to be confidently argued, which I the rather do, that by ſuch I may make way for, and ſhorten the anſwers I am to give to the arguments e'er long to be examined.

FIRST then, whereas the great care and vigilancy of nature, for the common good of the univerſe, is wont to be demonſtrated from the watchful care ſhe takes to prevent or repleniſh a vacuum, which would be very prejudicial to the fabrick of the world: I argue the quite contrary from the phænomena, that occur about a vacuum. For whereas it is alledged, that nature, in great pumps, and in the like caſes, lifts up the heavy body of water in ſpight of its tendency towards the centre of the earth, to obviate, or fill up a vacuity; and that out of a gardener's pot, or inverted pipe, ſtopped at one end, neither the water, nor even quick-ſilver, that is near fourteen times as heavy, will fall down, leſt it ſhould leave a vacuum behind it; I demand, how it comes to paſs, that, if a glaſs-pipe be but a foot longer than 34 or 35 feet, or an inverted tube, filled with quick-ſilver, be but a finger's breadth longer than 30 inches, the water in the one, and the quick-ſilver in the other, will ſubſide, though the one will leave but about a foot, and the other but about an inch, of deſerted ſpace, which they call vacuum, at the top of the glaſs? Is it poſſible, that nature, that in pumps is ſaid to raiſe up every day ſo many hundred tun of water, and, if you believe the ſchools, would raiſe it to any height, (leſt there ſhould be a vacuum) ſhould not have the diſcretion, or the power, to lift up, or ſuſtain, as much water as would ſerve to fill one foot in a glaſs tube, or as much quick-ſilver, as an inch of a ſlender pipe will contain, to obviate or repleniſh the vacuum, ſhe is ſaid ſo much to abhor? Sure, at this rate, ſhe muſt either have very little power, or very little knowledge of the power ſhe has. So likewiſe, when a glaſs-bubble is blown very thin at the flame of a lamp, and hermetically ſealed, whilſt it is very hot; the cauſe, that is rendered, why it is apt to break, when it grows cold, is, that the inward air, which was before rarefied by the heat, coming to be condenſed by the cold,

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left the ſpace deſerted by the air, that thus contracts itſelf, ſhould be left void, nature, with violence, breaks the glaſs in pieces: but, by theſe learned men's favour, if the glaſs be blown but a little ſtronger than ordinary, though at the flame of a lamp, the bubble, as I have often tried, will continue unbroken, in ſpight of nature's pretended abhorrency of a vacuum; which needs not at all to be recurred to in the caſe: for the reaſon, why the thin glaſs broke not when it was hot, and did when it grew cold, is plainly this; that, in the former ſtate, the agitation of the included air, by the heat, did ſo ſtrengthen the ſpring of it, that the glaſs was thereby aſſiſted and enabled to reſiſt the weight of the incumbent air; whereas, upon the ceſſation of that heat, the debilitated ſpring of the internal being unable to aſſiſt the glaſs, as formerly, to reſiſt the preſſure of the external air, the glaſs itſelf being too thin, becomes unable to ſupport the weight or preſſure of the incumbent air; the atmoſphærical pillar, that leans upon a bubble of about two inches diameter, amounting to above one hundred pound weight, as may be manifeſtly concluded from a late experiment, that I have tried, and you may meet with in another paper. And the reaſon, why, if the bubble be blown of a due thickneſs, it will continue whole after it is cold, is, that the thickneſs of it, though but faintly aſſiſted by the weakened ſpring of the included air, is ſufficient to ſupport the weight of the incumbent air, though, ſeveral times, I have obſerved the preſſure of the atmoſphere, and the reſiſtence of the bubble, to have been, by accident, ſo near the equipollent, that a much leſs outward force than one would imagine, applied to the glaſs, as, perhaps, a pound, or a leſs weight, gently laid on it, would enable the outward air to break it, with noiſe, into a multitude of pieces. And, now give me leave to conſider, how ill this experiment, and the above-mentioned phænomena, that happen in glaſs-pipes, wherein water and quick-ſilver ſubſide, agree with the vulgar apprehenſion men have of nature: for, if in caſe ſhe did not hinder the falling down of the water, or the quickſilver, there would be no ſuch vacuum produced, as ſhe is ſaid to abhor; why does ſhe ſeem ſo ſolicitous to hinder it? And why does ſhe keep three or four and thirty feet of water in perpendicular height, contrary to the nature of all heavy bodies, ſuſpended in the tube? And why does ſhe furiouſly break in pieces a thin ſealed bubble, ſuch as I come from ſpeaking of, to hinder a vacuum? if, in caſe ſhe did not break it, no vacuum would enſue? And, on the other ſide, if we admit her endeavours, to hinder a vacuum, not to have been ſuperfluous, and conſequently fooliſh, we muſt confeſs, that, where theſe endeavours ſucceed not, there is really produced ſuch a vacuum, as ſhe is ſaid to abhor: ſo that, as I was ſaying, either ſhe muſt be very indiſcreet to trouble herſelf, and to tranſgreſs her own ordinary laws, to prevent a danger ſhe need not fear; or her ſtrength muſt be very ſmall, that is not able to fill a vacuity, that half a pint of water, or an ounce of quick-ſilver, may repleniſh; or break a tender glaſs-bubble, which, perhaps, a pound weight on it would, with the help of ſo light a body as the incumbent air, cruſh in pieces.

The other grand inſtance, that is given of the wiſdom of nature, and her watchfulneſs for the good of the whole world, is the appetite ſhe has implanted in all heavy bodies, to deſcend to the centre of the earth, and in all light ones, to aſcend towards heaven; or, as ſome would have it, towards the element of fire, contiguous to the orb of the moon. But for poſitive levity, till I ſee it better proved, than it hath hitherto been, I allow no ſuch thing implanted in ſublunary bodies; the prepollent gravity of ſome ſufficing to give others a comparative or reſpective lightneſs. As a piece of oak, or the like wood, being let go in the air, falls down by its own gravity, or rather by virtue of the efficient of that gravity; but if it be let go under water, it will, though it be never ſo great a log or piece of timber, aſcend, with a conſiderable force, to the top of the water; which, I hope, will not be aſcribed to a poſitive levity, ſince, when it deſcended in the air, it was by its gravity, that it did ſo. But not to inſiſt on this, nor to take notice, how wiſely nature has implanted in all heavy bodies an appetite to deſcend to the centre of the earth, which, being but a point, is not able to contain any one of them; not to urge theſe things, I ſay, I will only invite you to conſider one of the moſt familiar things, that occur among heavy bodies.

For if, for example, you let fall a ball upon the ground, it will rebound to a good height, proportionable to that, from whence you let it fall, or, perhaps, will make ſeveral leſſer rebounds, before it come to reſt. If it be now aſked, why the ball, being let out of your hand, does not fall on this or that ſide, or move upwards, but falls directly towards the centre of the earth, by that ſhorteſt line, (which mechanicians call *linea directionis*) which is the diameter of the earth prolonged to the centre of gravity of the ball? it will be readily anſwered, that this proceeds from the ball's gravity, *i. e.* an innate appetite, whereby it tends to the centre of the earth the neareſt way. But then I demand, whence comes this rebound, *i. e.* this motion upwards? for it is plain, it is the genuine conſequence of the motion downwards, and therefore is increaſed according as that motion in the ball was increaſed by falling from a greater height: ſo that it ſeems, that nature does, in ſuch caſes, play a very odd game, ſince ſhe forces a ball, againſt the laws of heavy bodies, to aſcend divers times upwards, upon the account of that very gravity, whoſe office it is to carry it downwards the directeſt way; and, at leaſt, ſhe ſeems, in ſpight of the wiſdom aſcribed to her, to take her meaſures very ill, in making the ball move downwards with ſo much violence, as makes it divers times fly back from the place ſhe intended it ſhould go to; as if a ball, which a child can play with, and direct as he pleaſes, were ſo unweildy a thing, that nature cannot manage it, without letting it be hurried on with far greater violence, than her deſign requires.

THE reflection I have been making on a ball may (*mutatis mutandis*, as they ſpeak) be applied to a pendulum. For, ſince it is unanimouſly affirmed by all, that have written of it, that it falls to the perpendicular, upon the account of its gravity; it muſt not be denied, that it is from a motion proceeding from the ſame gravity, that the ſwinging weight paſſes beyond the perpendicular, and conſequently aſcends, and oftentimes makes a multitude of diadroms, or vibrations; and conſequently does very frequently aſcend, before it comes to reſt in the perpendicular; which is the poſition, wherein its gravity is beſt complied with, and which therefore it had been beſt ſettled in at firſt.

I SHALL not here mention thoſe grand anomalies, or exorbitances, even in the vaſter bodies of the univerſe; ſuch as earthquakes, that reach ſome hundreds of leagues, deluges, deſtructive eruptions of fire, famines of a large ſpread, raging peſtilences, cœleſtial comets, ſpots in the ſun, that are recorded to have obſcured it for many months; the ſudden appearing, the diſappearing, and the re-appearing of ſtars, that have been judged to be as high as the region of the fixed ones: I will not, I ſay, inquire, how far theſe anomalies agree to the character wont to be given of nature's watchfulneſs and vigilancy; becauſe probably I may have hereafter a fit opportunity to do it, and muſt now proceed to the remaining inſtances I promiſed you, which are taken from what happens to animals, as ſoon as I ſhall have diſpatched ſome conſiderations and advertiſements, that ſeem neceſſary to be premiſed to what I have to offer about that difficult ſubject.

IF the paſt diſcourſe give riſe to a queſtion, *Whether the world, and the creatures, that compoſe it, are as perfect as they could be made?* the queſtion ſeems to me, becauſe of the ambiguity of the terms, too intricate to be reſolved by a ſingle anſwer: but yet, becauſe the problem is not wont to be diſcuſſed, and is, in my opinion, of moment, in reference to natural theology; I ſhall venture briefly to intimate ſome of the thoughts, that occurred to me about it; having firſt declared, that I am, with reaſon, very backward to be poſitive in a matter of this nature, the extent of the divine power and wiſdom being ſuch, that its bounds, in caſe it have any, are not known to me.

THIS premiſed, I conſider, that the ſenſe of the queſtion may be, whether God could make the material world, and the corporeal creatures it conſiſts of, better and more perfect than they are? ſpeaking in a general way and abſolute ſenſe: or elſe, whether the particular kinds or orders of the creatures, in the world, could any of them be made more perfect or better, than they have been made?

TO anſwer the queſtion in the firſt-named ſenſe of it, I think it very unſafe to deny, that God, who is almighty and omniſcient, and an owner of perfections, which, for aught we know, are participable in more different manners and degrees, than we can comprehend, could not diſplay, if it be not fitter to ſay adumbrate them, by creating a work more excellent than this work: and his immenſe power and unexhauſted wiſdom conſidered, it will not follow, either that becauſe this world of ours is an admirable piece of workmanſhip, the divine architect could not have bettered it; or, becauſe God himſelf is able to make a greater maſter-piece, this exquiſitely contrived ſyſtem is not admirably excellent.

BUT the propoſed queſtion, in the other ſenſe of it, will require ſome more words to reſolve it. For if we look upon the ſeveral ſpecies of viſible creatures under a more abſolute conſideration, without reſpect to the great ſyſtem of the univerſe, of which they are parts, or to the more particular deſigns of the creator; it ſeems manifeſt, that many ſorts of creatures might have been more perfect than they are, ſince they want many completing things, that others are endowed with: as an oyſter, that can neither hear, nor ſee, nor walk, nor ſwim, nor fly, *&c.* is not ſo perfect a creature, as an eagle, or an elephant, that have both thoſe ſenſes, that the oyſter wants, and a far more active faculty of changing places; and of this inequality of perfection in creatures of differing kinds, the examples are too obvious to need to be enumerated. But if the queſtion be better propoſed, and it be inquired, not whether God could have made more perfect creatures, than many of thoſe he has made, for that it is plain he could do ſo, becauſe he has done it; but whether the creatures were not ſo curiouſly and ſkilfully made, that it was ſcarce poſſible they could have been better made, with due regard to all the wiſe ends he may be ſuppoſed to have had in making them, it will be hard to prove a negative anſwer.

THIS I ſhall endeavour to illuſtrate by a ſuppoſition. If one ſhould come into the well-furniſhed ſhop of an excellent watch-maker, and ſhould there ſee a plain watch, deſigned barely to ſhew the hour of the day; another, that ſtrikes the hours; a third, that is alſo furniſhed with an alarum; a fourth, that, beſides theſe, ſhews the month current, and the day of it; and laſtly, a fifth, that over and above all theſe, ſhews the motions of the ſun, moon, and planets, the tides, and other things, which may be ſeen in ſome curious watches: in this caſe, I ſay, the ſpectator, ſuppoſing him judicious, would indeed think one of theſe watches far more excellent and compleat than another; but yet he would conclude each of them to be perfect in its own kind, and the plain watch to anſwer the artificer's idea and deſign in making it, as well as the more compounded and elaborate one did. The ſame thing may, in ſome circumſtances, be further illuſtrated, by conſidering the copy of ſome excellent writing-maſter, for though there we may find ſome leaves written in an Italian hand, others in a ſecretary, and, in others, hands of other denominations; though one of theſe patterns may be much fairer, and more curious than another, if they be compared together; yet, if we conſider their equal conformity to the reſpective ideas of the author, and the ſuitableneſs to the deſign he had of making each copy, not as curious, ſightly and flouriſhing as he could, but as conformable to the true idea of the ſort of hand he meant to exhibit, and the deſign he had to ſhew the variety, number and juſtneſs of his ſkill, by that of the patterns he made compleat in the reſpective kinds; we ſhall not think, that any of them could have been bettered by him: and if he ſhould have made a text-hand as fair as a Roman-hand, by giving it more beauty and ornament, he would not have made it better in its kind, but ſpoiled it, and, by a flouriſh of his ſkill, might have given a proof of his want of judgment.

But to return thither, whence I began to make this excurſion, perhaps, *Eleutherius*, you will object againſt the examples I have produced before it, that the exceptions I have taken at ſome of the proceedings of nature, may be as well urged againſt providence, and exclude the one as well as the other from the government of the world.

But to this I anſwer, that this objection is foreign to the queſtion, which is about men's notion of nature, not God's providence; which, if it were here my taſk to aſſert, I ſhould eſtabliſh it upon its proper and ſolid grounds; ſuch as the infinite perfections of the divine nature, which both engage and enable him to adminiſter his dominion over all things; his being the author and ſupporter of the world; the exquiſite contrivance of the bodies of animals, which could not proceed but from a ſtupendous wiſdom; the ſupernatural revelations and diſcoveries he has made of himſelf, and of his particular care of his creatures, by prophecies, apparitions, true miracles, and other ways, that tranſcend the power, or at leaſt over-rule the phyſical laws of motion in matter: by theſe, I ſay, and the like proper means, I would evince divine providence. But being not now obliged to make an attempt, which deſerves to be made very ſolemnly, and not in ſuch haſte, as I now write in; I ſhall at preſent only obſerve to you, that the caſe is very differing between providence and nature, and therefore there is no neceſſity, that the objections I have made againſt the latter, ſhould hold againſt the former. As, (to give you a few inſtances of the diſparity) in the firſt place, it appears not, nor is it likely, that it is the deſign of providence to hinder thoſe anomalies and defects, I have been mentioning; whereas it is ſaid, to be the duty and deſign of nature, and her only taſk, to keep the univerſe in order, and procure, in all the bodies, that compoſe it, that things be carried on in the beſt and moſt regular way, that may be, for their advantage. Secondly, nature is confeſſed to be a thing inferior to God, and ſo but a ſubordinate agent, and therefore cannot, without diſparagement to her power, or wiſdom, or vigilancy, ſuffer divers things to be done, which may, without degradation to God, be permitted by him, who is not only a ſelf-exiſtent and independent Being, but the ſupreme and abſolute Lord, and, if I may ſo ſpeak, the proprietor of the whole creation; whence both *Melchizidec* and *Abram* ſtile him, (*Gen.* xiv. 19, 23.) not only the moſt high God, but קנה *koneh*, poſſeſſing (or, as our verſion has it, poſſeſſor of) heaven and earth; and who, when he made the world, and eſtabliſhed the laws of motion, gave them to matter, not to himſelf: and ſo being obliged to none, either as his ſuperior or benefactor, he was not bound to make, or adminiſter, corporeal things after the beſt manner, that he could, for the good of the things themſelves; among which, thoſe, that are capable of gratitude, ought to praiſe and thank him for having vouchſafed them ſo much as they have, and have no right to except againſt his having granted them no more. And, as being thus obliged to none of his works, he has a ſovereign right to diſpoſe of them; ſo he has other attributes, which he may juſtly exerciſe, and both intend and expect to be glorified for, beſides his goodneſs to inferior creatures: and his wiſdom may be better ſet off to men, and perhaps to angels or intelligencies, by the great variety of his contrivances in his works, than by making them all of the excellenteſt kind; as ſhadows in pictures, and diſcords in muſic, ſkilfully placed and ordered, do much recommend the painter and the muſician. Perhaps it may be added, that the permitting the courſe of things to be ſomewhat violated ſhews, by the miſchief ſuch exorbitances do, how good God has been in ſettling and preſerving the orderly courſe of things. Thirdly, as God is a moſt abſolute and free, ſo he is an omniſcient, Being; and as, by his ſupreme dominion over the works of his hands, he has a right to diſpoſe of them, as he thinks beſt for his own glory; ſo upon the ſcore of his unfathomable wiſdom, he may have deſigns, and, if I may ſo ſpeak, reaches in the anomalies, that happen in the world, which we men are too ſhort-ſighted to diſcern; and may exerciſe as much wiſdom, nay, and as much providence (in reference to men, the nobleſt viſible object of his providence) in ſometimes (as in divine miracles) receding from what men call the laws of nature, as he did at firſt in eſtabliſhing them: whereas the office of nature being but to preſerve the univerſe in general, and particular bodies in it, after the beſt manner, that their reſpective conditions will permit; we know, what it is ſhe aims at, and conſequently can better diſcern, when ſhe miſſes of her aims, by not well acting what is preſumed to be her part. Fourthly, we muſt conſider, that, as God is an independent, free and wiſe, ſo he is alſo a juſt agent; and therefore may very well be ſuppoſed to cauſe many irregularities and exorbitances in the world, to puniſh thoſe, that men have been guilty of. And whereas nature is but a nurſing-mother to the creatures, and looks even upon wicked men, not in their moral but in their philoſophical capacities, God expreſly declares, in the ſacred ſcriptures, that, upon *Adam*'s fall, he *curſed the ground*, or *earth*, *for man's ſake*, Gen. iii. 17, 18. and that there is no penal evil in the city, that is not derived from him, *Amos* iii. 6. He is not over-ruled, as men are fain to ſay of erring nature, by the head-ſtrong motions of the matter, but ſometimes purpoſely over-rules the regular ones, to execute his juſtice; and therefore plagues, earthquakes, inundations, and the like deſtructive calamities, though they are ſometimes irregularities in nature, yet for that very reaſon they are deſigned by providence, which intends, by them, to deprive wicked men of that life, or of thoſe bleſſings of life, whereof their ſins have rendered them unworthy. But, whilſt I mention deſigns, I muſt not forget, that mine was only to give you a taſte of the conſiderations, by which one may ſhew, that ſuch things, as manifeſt nature to act unſuitably to the repreſentation, that is made of her, may yet, when attributed to divine providence, be made out to have nothing inconſiſtent with it.

And yet, ſomewhat further to clear this weighty matter, and particularly ſome things but briefly hinted in what I have been lately diſcourſing, I think it fit, before I deſcend to the particulars, that I am apt to employ againſt the vulgar notion of nature, to premiſe ſomewhat by way of caution, that I may do ſome right (though I can never do enough,) to divine providence; and take care betimes, that no uſe, injurious to it, may be made of any thing, that my argument hath obliged me, or will oblige me, to ſay about that imaginary thing, vulgarly called nature, either in this or the ſixth ſection, or any other part of our preſent inquiry.

I conceive then, that the divine author of things, in making the world, and the particular creatures, that compoſe it, had reſpect to ſeveral ends; ſome of them knowable by us men, and others hid in the abyſs of the divine wiſdom and counſels; and that of thoſe ends, which are either manifeſt to us, or at leaſt diſcoverable by human ſagacity and induſtry, ſome of the principles are, the manifeſtation of the glory of God, the utility of man, and the maintenance of the ſyſtem of the world, under which is compriſed, the conſervation of particular creatures, and alſo the propagation of ſome kinds of them.

But this general deſign of God, for the welfare of man and other creatures, is not (as I conceive) to be underſtood, but with a twofold limitation.

For firſt, though men, and other animals, be furniſhed with faculties or powers, and other requiſites, to enable them to preſerve themſelves, and procure what is neceſſary for their own welfare; yet this proviſion, that God has been pleaſed to make for them, is made with reference to what regularly, or what moſt uſually, happens to beings of that ſpecies or ſort, that they belong to, but not with regard to ſuch things, as may happen to them irregularly, contingently, and (in compariſon of the others,) unfrequently. Thus it is, in general, far better for mankind, that women, when they are brought to bed, ſhould have their breaſts filled with milk, to give ſuck to the new-born babe, than that they ſhould not; though ſometimes, as if the child die in the delivery, or preſently after, and in ſome other caſes alſo, the plentiful recourſe of milk to the mother's breaſts proves troubleſome and inconvenient, and ſometimes alſo dangerous to her. Thus a head of hair is, for the moſt part, uſeful to the perſon, whether man or woman, that nature has furniſhed with it; though in ſome caſes (as of conſumptions, and in a few other circumſtances) it happens to be prejudicial to the wearer; and therefore phyſicians do often, with good ſucceſs, preſcribe, that it be ſhaven off. Thus the inſtinct, that hens have to hatch their eggs and take care of their young, is, in general, very uſeful, if not neceſſary, for the conſervation of that ſpecies of birds; and yet it ſometimes miſguides and deludes them, when it makes them take a great deal of pains to brood upon thoſe duck-eggs, that houſe-wives, (having taken away the bird's own eggs) lay in her neſt, which makes her very ſolicitous to hatch and take care of ducklings, inſtead of chickens. Thus it is an inſtitution, that ordinarily is profitable for man, that his ſtomach ſhould nauſeate or reject things, that have a loathſome taſte or ſmell, becauſe the generality of thoſe things, that are provided for his nouriſhment, are well, or, at leaſt, not ill taſted; and yet, on ſome occaſions of ſickneſs, that diſpoſition of the ſtomach to refuſe, or vomit up, nauſeous purges, and other diſtaſtful medicines, (as ſuch remedies are uſually loathſome enough) proves very prejudicial, by being a great impediment to the recovery of health. And thus (to be ſhort) the paſſions of the mind, ſuch as fear, joy and grief, are given to man, for his good, and, when rightly uſed, are very advantageous, if not abſolutely neceſſary, to him; though, when they grow unruly, or are ill-managed, as it but too often happens, they frequently prove the cauſes of diſeaſes, and of great miſchief, as well to the paſſionate man himſelf, as to others.

The ſecond limitation (which has a natural connexion with the former,) is this; that the omniſcient author of things, who, in his vaſt and boundleſs underſtanding, comprehended at once the whole ſyſtem of his works, and every part of it, did not mainly intend the welfare of ſuch or ſuch particular creatures, but ſubordinated his care of their preſervation and welfare to his care of maintaining the univerſal ſyſtem and primitive ſcheme or contrivance of his works, and eſpecially thoſe Catholic rules of motion, and other grand laws, which he at firſt eſtabliſhed among the portions of the mundane matter. So that, when there happens ſuch a concourſe of circumſtances, that particular bodies, fewer or more, muſt ſuffer, or elſe the ſettled frame, or the uſual courſe of things, muſt be altered, or ſome general law of motion muſt be hindered from taking place; in ſuch caſes, I ſay, the welfare and intereſt of man himſelf (as an animal) and much more that of inferior animals, and of other particular creatures, muſt give way to the care, that providence takes of things of a more general and important nature or condition.

Thus (as I formerly noted) God eſtabliſhed the lines of motion, which the ſun and the moon obſerve, though he foreſaw, that from thence there would neceſſarily, from time to time, enſue eclipſes of thoſe luminaries; which he choſe rather to permit, than to alter that courſe, which, on ſeveral accounts, was the moſt convenient. Thus a blown bladder, or a foot-ball, falling from a conſiderable height upon the ground, rebounds upwards, and ſo, contrary to the nature of heavy bodies, moves from the centre of the earth, leſt the Catholic laws of motion, whereby the ſpringineſs and reflection of bodies, in ſuch circumſtances, are eſtabliſhed, ſhould be violated or intrenched upon.

Thus, he thought not fit to furniſh ſheep with paws, or tuſks, or ſwiftneſs, or animoſity, or craft, to defend or preſerve themſelves from wolves, and foxes, and other beaſts of prey. And tame and fearful birds, ſuch as hens, are ſo ill provided for defence, that they ſeem deſigned to be the food of hawks, kites, and other rapacious ones. Thus oiſters, having neither eyes nor ears, are not near ſo well provided for, as the generality of beaſts and birds, and even moſt other fiſhes. And thus ſilk-worms (to name no other caterpillars,) uſually (at leaſt in theſe countries,) live not much above half a year, being leſs furniſhed with the requiſites of longevity, than the generality of birds, and beaſts, and fiſhes.

I have thought fit to lay down the two foregoing limitations, partly becauſe they will be of uſe to me hereafter, and partly becauſe they contain ſomething, that may be added to what hath been lately repreſented on behalf of the divine providence (as it falls under the naturiſt's conſideration.) For by theſe limitations we may perceive, that it is not juſt preſently to deny, or cenſure the providence of God, whenever we ſee ſome creatures leſs compleatly furniſhed to maintain themſelves; or ſome caſes leſs provided for, than we think they might be; or ſeeming anomalies permitted, which we look upon as miſchievous irregularities: for the welfare of men, or of this or that other particular ſort of creatures, being not the only, nor, in likelihood, the principal end of God, in making the world; it is neither to be admired nor reprehended, that he has not provided for the ſafety and conveniency of particular beings any further, than well conſiſts with the welfare of beings of a more conſiderable order, and alſo will comport with his higher ends, and with the maintenance of the more general laws and cuſtoms, ſettled by him among things corporeal. So that divers ſeeming anomalies and incongruities, whence ſome take occaſion to queſtion the adminiſtration of things, and to deny the agency of providence, do not only comport with it, but ſerve to accompliſh the deſign of it.

I have the more expreſly declared my mind on this occaſion, becauſe, indeed, of the two main reaſons, which put me upon ſo difficult a work, as I foreſaw this treatiſe would be, as one was the love I bear to truth and philoſophical freedom; ſo the other was a juſt concern for religion. For thinking it very probable, that in ſo inquiſitive an age as this, ſome obſervations, like mine, about nature itſelf, might come into the minds of perſons ill affected to divine providence, who would be glad and forward to wreſt them, and make a perverſe uſe of them; I thought it better, that ſuch notions ſhould be candidly propoſed by one, that would take care to accompany them with thoſe cautions, that may keep them from being injurious to religion.

Having premiſed the two foregoing advertiſements to obviate miſconſtructions, I hope I may now ſafely proceed to particulars; whereof, for brevity's ſake, I ſhall here mention but a few, leaving you to add to them thoſe others, that occur in other parts of this treatiſe.

In the firſt place then, I ſhall take notice, that there are ſeveral inſtances of perſons, that have been choaked with a hair, which they were unable, either to cough up, or ſwallow down. The reaſon of this fatal accident is probably ſaid to be the irritation, that is made by the ſtay of ſo unuſual a thing, as a hair, in the throat; which irritation occaſions very violent and diſorderly, or convulſive motions to expel it, in the organs of reſpiration, by which means the continual circulation of the blood, neceſſary to the life of man, is hindered, the conſequence whereof is ſpeedy death. But this agrees very ill with the vulgar ſuppoſition of ſuch a kind and provident being, as they repreſent nature, which is always at hand to preſerve the life of animals, and ſuccour them in their (phyſical) dangers and diſtreſſes, as occaſion requires: for ſince a hair is ſo ſlender a body, that it cannot ſtop the throat ſo, as to hinder either the free paſſage of meat and drink into the ſtomach, or that of the air to or from the lungs, (as may be argued from divers no-way mortal excreſcences and ulcers in the throat;) were it not a great deal better for nature to let the hair alone, and ſtay until the juices of the body have reſolved or conſumed it, or ſome favourable accident have removed it, than, like a paſſionate and tranſported thing, oppoſe it like a fury with ſuch blind violence, as, inſtead of ejecting the hair, expels the life of him, that was troubled with it?

HOW the care and wiſdom of nature will be reconciled to ſo improper and diſorderly a proceeding, I leave her admirers to conſider. But it will appear very reconcileable to providence, if we reflect back upon the lately given advertiſement: for, in regard of the uſe and neceſſity of deglutition, and in many caſes of coughing and vomiting, it was, in the general, moſt convenient, that the parts, that miniſter to theſe motions, ſhould be irritated by the ſudden ſenſe of things, that are unuſual, though perhaps they would not be otherwiſe dangerous or offenſive; becauſe (as we formerly noted,) it was fit, that the providence of God ſhould, in making proviſion for the welfare of animals, have more regard to that, which uſually and regularly befals them, than to extraordinary caſes or unfrequent accidents.

THOUGH moſt women are offended with the ſtink of the ſmoking wick of a candle, which is no more than men alſo are; yet it has been frequently obſerved, that big-bellied women have been made to miſcarry by the ſmell of an extinguiſhed candle, which would before have indeed diſpleaſed, but not endangered, the ſame perſons: ſo that it ſeems nature is, in theſe caſes, very far from being ſo prudent and careful, as men are wont to fancy her; ſince by an odour, (which, if calmly received, would have done no harm to the teeming woman,) ſhe is put into ſuch unruly tranſports; and inſtead of watching for the welfare of the teeming woman, whoſe condition needed a more than ordinary meaſure of her care and tenderneſs, ſhe violently precipitates her poor charge into a danger, that oftentimes proves fatal, not only to the mother, but the child alſo.

THE improper, and oftentimes hurtful, courſes, that nature takes in perſons, that are ſick, ſome of one diſeaſe, ſome of another, will be hereafter taken notice of in opportune places; and therefore, for the preſent, I ſhall only obſerve, that nature ſeems to do her work very weakly, or bunglingly, in the production of monſters, whoſe variety and numerouſneſs is almoſt as great, as their deformity, or their irregularity; inſomuch that ſeveral volumes have been written, and many more might have been, to give the deſcription of them. How theſe groſs aberrations will agree with that great uniformity, and exquiſite ſkill, that is aſcribed to nature in her ſeminal productions, I leave the naturiſts to make out. I know, that ſome of them lay the fault upon the ſtubborneſs of the matter, that would not be obſequious to the plaſtic power of nature; but I can hardly admit of this account from men of ſuch principles, as they are, that give it: for it is ſtrange to me, they ſhould pretend, that nature, which they make a kind of ſemi-deity, ſhould not be able to mould and faſhion ſo ſmall, and ſoft, and tractable, a portion of matter, as that, wherein the firſt model and efformation of the embrio is made; when, at the ſame time, they tell us, that it is able, in ſucking-pumps, to raiſe, and, if need be, ſuſtain whole tuns of water, to prevent a vacuum; and can, in mines, toſs up into the air houſes, walls, and caſtles, and perhaps the rocks they are built on, to give the kindled gun-powder the expanſion, that its new ſtate requires.

OTHER arguments, that, by a light change and eaſy application, may be made uſe of and added to theſe, againſt the vulgar notion of nature, may be met with in divers parts of this treatiſe, and eſpecially in the VIIth ſection; for which reaſon (among others) I decline lengthening this part of my diſcourſe with the mention of them.

I FORESEE it may be ſaid, that unleſs we admit ſuch a being, as nature, to contrive and manage things corporeal, and in a regular and methodical way direct them to their reſpective ends, there will appear no viſible footſteps or proof of a divine wiſdom in the corporeal world: and this argument, I confeſs, is ſo ſpecious, that it was one of the things, that made me the longeſt heſitate, what I ſhould think of the received notion of nature. But having further conſidered the matter, I ſaw it might be anſwered, that the curious contrivance of the univerſe, and many of its parts, and the orderly courſe of things corporeal, with a manifeſt tendency to determinate ends, are matters of fact, and do not depend upon the ſuppoſition of ſuch a being, as they call nature; but ſetting aſide this or that hypotheſis, may be known by inſpection, if thoſe, that make the inſpection, be attentive and impartial: as when a man ſees a human body ſkilfully diſſected by a dexterous anatomiſt, he cannot, if he be intelligent and unprejudiced, but acknowledge, that there is a moſt curious and exquiſite contrivance in that incomparable engine, and in the various parts of it, that are admirably fitted for diſtinct and determinate functions or uſes. So that I do not at all, nor indeed can, ſuppreſs the manifeſt tokens of wiſdom and deſign, that are to be obſerved in the wonderful conſtruction and orderly operations of the world and its parts; but I endeavour to refer theſe indications of wiſdom to the true and proper cauſe. And whereas, in the hypotheſis of the objectors, there may be three cauſes aſſigned of theſe ſpecimens or footſteps of wiſdom; namely, God, nature, and chance; if, according to the doctrine by me propoſed, nature be laid aſide, the competition will remain only between God and chance; and ſure he muſt be very dull, or very ſtrongly prejudiced, that ſhall think it reaſonable to attribute ſuch admirable contrivances and ſuch regular conducts, as are obſervable in the corporeal world, rather to chance, (which is a blind and ſenſeleſs cauſe, or indeed no proper cauſe at all, but a kind of *ens rationis*) than to a moſt intelligent being, from which the curiouſeſt productions may with congruity be expected: whereas, if ſuch a celebrated thing, as nature is commonly thought, be admitted, it will not be near ſo eaſy to prove the wiſdom (and conſequently the exiſtence) of God by his works, ſince they may have another cauſe, namely, that moſt watchful and provident being, which men call nature. And this will be eſpecially difficult in the Peripatetic hypotheſis of the eternity (not of matter only, for in that the atomiſts and others agreed with them, but) of the world: for, according to this account of the univerſe, there appears no neceſſity, that God ſhould have any thing to do with it, ſince he did not make this automaton, but it was always ſelf-exiſtent, not only as to matter, but to form too; and as for the government or adminiſtration of the bodies it conſiſts of, that is the proper buſineſs of nature. And if it be objected, that this being is by its aſſertors acknowledged to be ſubordinate to God; I ſhall anſwer, that as, upon the reaſons and authorities I elſewhere delivered, it may juſtly be queſtioned, whether many philoſophers, and perhaps ſome ſects of them, who are adorers of nature, confeſſed her to be but the ſubſtitute of a ſuperior being? ſo this diſtinction and ſubordination is not ſo eaſy to be proved againſt thoſe, that ſide with thoſe other antient philoſophers, who either acknowledged no ſuch thing, or expreſly denied it: Beſides that this objection ſuppoſes the exiſtence and ſuperiority of a deity, which therefore needs to be proved by other ways; whereas in the hypotheſis I propoſe, the ſame phænomena, that diſcover admirable wiſdom and manifeſt deſigns in the corporeal world, do themſelves afford a ſolid argument, both of the exiſtence and of ſome of the grand attributes of God, with which the reſt, that properly belong to him, have a neceſſary connexion.

SECT. VI.

V. HAVING, in the foregoing ſection, propoſed ſome of the conſiderations, that have diſſatisfied me with the received notion of nature, it may now be juſtly expected, that I ſhould alſo conſider, what I foreſee will be alledged in its behalf, by the more intelligent of its favourers: and I ſhall not deny the objections I am going to name to be conſiderable, eſpecially for this reaſon, that I am very unwilling to ſeem to put ſuch an affront upon the generality as well of learned men as of others, as to maintain, that they have built a notion of ſo great weight and importance upon ſlight and inconſiderable grounds.

THE reaſons, that I conceive may have induced philoſophers to take up, and rely on, the received notion of nature, are ſuch as theſe, that follow.

AND the firſt argument, as one of the moſt obvious, may be taken from the general belief, or, as men ſuppoſe, obſervation, that divers bodies, as particularly earth, water, and other elements, have each of them its natural place aſſigned it in the univerſe; from which place, if any portion of the element, or any mixt body, wherein that element predominates, happens to be removed, it has a ſtrong inceſſant appetite to return to it; becauſe, when it is there, it ceaſes either to gravitate, or (as ſome ſchool-men ſpeak) to levitate, and is now in a place, which nature has qualified to preſerve it, according to the axiom, that *locus conſervat locatum*.

To this argument I anſwer, that I readily grant, that there being ſuch a quantity of very bulky bodies in the world, it was neceſſary they ſhould have places adequate to their bigneſs; and it was thought fit by the wiſe architect of the univerſe, that they ſhould not be all blended together, but that a great portion of each of them ſhould, at the beginning of things, be diſpoſed of and lodged in a diſtinct and convenient place. But when I have granted this, I ſee not any neceſſity of granting likewiſe, what is aſſerted in the argument above propoſed: for inanimate bodies having no ſenſe or perception, (which is the prerogative of animadverſive beings) it muſt be all one to them in what place they are, becauſe they cannot be concerned to be in one place rather than in another, ſince ſuch a preference would require a knowledge, that inanimate things are deſtitute of; and, for the ſame reaſon, a portion of an element, removed by force or chance, from what they call its proper place, can have no real appetite to return thither: for, who tells it, it is in an undue place, and that it may better its condition by removing into another? And who informs it, whether that place lies on this hand of it, or that hand of it, or above it, or beneath it? Some philoſophers indeed have been ſomewhat aware of the weakneſs of the argument drawn from the vulgarly propoſed inſtance (which yet is the beſt that is wont to be employed,) of earthy bodies, which being let fall from the top of a houſe, or thrown into the air, do of themſelves fall in a direct line towards the centre of the earth; and therefore they have ſtrengthned this argument, as far as might be, by pretending, that theſe bodies have not indeed, as former philoſophers were wont to think, an appetite to deſcend to the centre of the earth, but to the great maſs of their connatural bodies. I will not therefore accuſe theſe philoſophers of the inconſiderate opinion of their predeceſſors, who would have nature make all heavy things affect to lodge themſelves in the centre of the earth, which (as was formerly noted,) being but a point, cannot contain any one of them, (how little ſoever it be;) but yet the hypotheſis of theſe moderns is liable, though not to that, yet to other weighty objections.

FOR the firſt argument I lately employed will hold good againſt theſe philoſophers too, it not being conceivable, how an inanimate body ſhould have an appetite to rejoin homogeneous bodies, neither whoſe ſituation, nor whoſe diſtance from it, it does at all know.

SECONDLY, It does not appear, that all bodies have ſuch an appetite, as is preſumed, of joining themſelves to greater maſſes of connatural bodies; as if you file the end of an ingot or bar of ſilver or of gold, the filings will not ſtick to their own maſs, though it be approached never ſo near, or made to touch; them and much leſs will they leap to it, when it is at a diſtance from them. The like may be ſaid almoſt of all conſiſtent bodies we are acquainted with, except the loadſtone and iron, and bodies, that participate of one of thoſe two.

THIRDLY, It is obvious to them, that will obſerve, that that, which makes lumps of earth, or terreſtrial matter, fall through the air to the earth, is ſome general agent, whatever that be, which, according to the wiſe diſpoſition of the author of the univerſe, determines the motion of thoſe bodies we call heavy, by the ſhorteſt ways, that are permitted them, towards the central part of the terraqueous globe; whether the body, put into motion downwards be of the ſame, or a like, or a quite differing nature, from the greater maſs of matter, to which when it is aggregated, it reſts there. If, from the ſide of a ſhip you let fall a chip of wood out of your hand, when your arm is ſo ſtreched out, that the perpendicular, or ſhorteſt line, between that and the water, lies never ſo little without the ſhip, that chip will fall into the ſea, which is a fluid body, and quite of another nature than itſelf, rather than ſwerve in the leaſt from the line of direction, as mechanicians call it, to rejoin itſelf to the great bulk of wood, whereof the ſhip, though never ſo big, conſiſts. And, on the other ſide, if a man, ſtanding upon the ſhore juſt by the ſea, ſhall pour out a glaſs of water, holding the glaſs juſt over his feet, that water will fall into the ſand, where it will be immediately ſoaked up and diſperſed, rather than deviate a little, to join itſelf to ſo great a maſs of connatural body, as the ocean is.

AND as to what is generally believed, and made part of the argument, that I am anſwering, that water does not weigh in water, becauſe it is in its own natural place, and *elementa in proprio loco non gravitant*; I deny the matter of fact, and have convinced divers curious perſons by experiment, * that water does gravitate in water, as well as out of it, though indeed it does not prægravitate, becauſe it is counter-ballanced by an equal weight of collateral water, which keeps it from deſcending.

AND laſtly, for the maxim, that *locus conſervat locatum*; beſides that it has been proofleſly aſſerted, and therefore, unleſs it be cautiouſly explained, I do not think myſelf bound to admit it; beſides this, I ſay, I think, that either the proper place of a body cannot be inferred, as my adverſaries would have it, from the natural tendency of a body to it; or elſe it will not hold true in general, that *locus conſervat locatum*: as when, for inſtance, a poor unlucky ſeaman falls from the main-yard of a ſhip into the water, does the ſea, to which he makes ſuch haſte, preſerve him or deſtroy him? And when, in a foul chimney, a lump of ſoot falls into the hearth, and preſently burns up there; can we think, that the wiſdom of nature gave the ſoot an appetite to haſten to the fire, as a greater bulk of its connatural body, or a place provided by nature for its conſervation.

AND now I ſpeak of ſuch an innate appetite of conjunction between bodies, I remember, what I lately forgot to mention in a fitter place; that bubbles themſelves may overthrow the argument I was anſwering. For if a bubble happens to ariſe from the bottom of a veſſel to the upper part of it, we are told, that the haſte, wherewith the air moves thorough water, proceeds from the appetite it has to quit that preternatural place, and rejoin the element, or great maſs of air, detained at the very ſurface of the water by a very thin ſkin of that liquor, together with which it conſtitutes a bubble. Now I demand, how it comes to paſs, that this appetite of the air, which, when it was at the bottom of the water, and alſo in its paſſage upwards, is ſuppoſed to have enabled it to aſcend with ſo much eagerneſs and force, as to make its way thorough all the incumbent water, (which poſſibly was very deep,) ſhould not be able, when the air is arrived at the very top of the water, to break through ſo thin a membrane of water, as uſually ſerves to make a bubble, and which ſuffices to keep it from the beloved conjunction with the great maſs of the external air? eſpecially ſince they tell us, that natural motion grows more quick, the nearer it comes to the end or place of reſt; the appetites of bodies encreaſing with their approaches to the good they aſpire to; upon which account, falling bodies, as ſtones, *&c.* are ſaid (though falſely) to encreaſe their ſwiftneſs, the nearer they come to the earth. But if, ſetting aſide the imaginary appetite of the air, we attribute the aſcenſion of bubbles to the gravity and preſſure upwards of the water, it is eaſy hydroſtatically to explicate, why bubbles often move ſlower, when they come near the ſurface of the water, and why they are detained there; which laſt phænomenon proceeds from this, that the preſſure of the water being there inconſiderable, it is not able to make the air quite ſurmount the reſiſtance made by the tenacity of the ſuperficial part of the water; and therefore in good ſpirit of wine, whoſe tenacity and glutinouſneſs is far leſs than that of water, bubbles rarely continue upon the ſurface of the liquor, but are preſently broken and vaniſh.

AND to make this preſumed appetite of the ſmaller portions of the air to unite with the great maſs of it, appear the leſs probable; I ſhall add, that I have often obſerved, that water, in that ſtate, which is uſually called its natural ſtate, is wont to have ſtore of aerial particles mingled with it, notwithſtanding the neighbourhood of the external air, that is incumbent on the water; as may appear by putting a glaſs full of water into the receiver of the new pneumatical engine: for the preſſure of the external air being by the

* See the Appendix to the *Hydroſtat. Paradoxes.*

the pump taken off, there will, from time to time, diſcloſe themſelves in the water a multitude of bubbles, made by the aerial particles, that lay concealed in that liquor.

AND I have further tried, as I doubt not but ſome others alſo have done, that by exactly incloſing in a conveniently ſhaped glaſs ſome water, thus freed from the air, and leaving a little air at the top of the veſſel, which was afterwards ſet by in a quiet place; the corpuſcles of that incumbent air did, one after another, inſinuate themſelves into the water, and remained lodged in it; ſo little appetite has air, in general, to flie all aſſociation with water, and make its eſcape out of that liquor; though, when ſenſible portions of it happen to be under water, the great inequality in gravity between thoſe two fluids makes the water preſs up the air. But though it were eaſy to give a mechanical account of the phænomena of mingled air and water; yet, becauſe it cannot be done in few words, I ſhall not here undertake it, the phænomena themſelves being ſufficient to render the ſuppoſition of my adverſaries improbable.

ANOTHER argument, in favour of the received opinion of nature, may be drawn from the ſtrong appetite, that bodies have to recover their natural ſtate, when by any means they are put out of it, and thereby forced into a ſtate, that is called preternatural; as we ſee, that air being violently compreſſed in a blown bladder, as ſoon as the force is removed, will return to its firſt dimenſions; and the blade of a ſword being bent, by being thruſt againſt the floor, as ſoon as the force ceaſes, reſtores itſelf, by its innate power, to its former ſtraightneſs; and water, being made hot by the fire, when it is removed thence, haſtens to recover its former coldneſs.

BUT though I take this argument to have much more weight in it, than the foregoing, becauſe it ſeems to be grounded upon ſuch real phænomena of nature, as thoſe newly recited, yet I do not look upon it as cogent.

IN anſwer to it therefore, I ſhall repreſent, that it appears by the inſtances lately mentioned, that the propoſers of the argument ground it on the affections of inanimate bodies. Now, an inanimate portion of matter being confeſſedly devoid of knowledge and ſenſe, I ſee no reaſon, why we ſhould not think it uncapable of being concerned to be in one ſtate or conſtitution, rather than another; ſince it has no knowledge of that, which it is in at preſent, nor remembrance of that, from which it was forced; and conſequently no appetite to forſake the former, that it may return to the latter: but every inanimate body, (to ſay nothing now of plants and bruit animals, becauſe I want time to launch into an ample diſcourſe) being of itſelf indifferent to all places and ſtates, continues in that place or ſtate, to which the action and reſiſtence of other bodies, and eſpecially contiguous ones, effectually determine it.

AS to the inſtance afforded by water, I conſider, that before it be aſſerted, that water, being heated, returns of itſelf to its natural coldneſs, it were fit, that the aſſertors ſhould determine, what degree or meaſure of coldneſs is natural to that liquor; and this, if I miſtake not, will be no eaſy taſk. It is true indeed, that, in reference to us men, water is uſually cold, becauſe its minute parts are not ſo briſkly agitated, as thoſe of the blood and juices, that are to be found in our hands, or other organs of feeling; but that water is actually cold in reference to frogs, and thoſe fiſhes, that live in it, whoſe blood is cold as to our ſenſe, has not, that I know of, been proved, nor is eaſy to be ſo. And I think it yet more difficult to determine, what degree of coldneſs is natural to water, ſince this liquor perpetually varies its temperature, as to cold and heat, according to the temper of the contiguous or the neighbouring bodies, eſpecially the ambient air. And therefore the water of an unſhaded pond, for inſtance, though it reſts in its proper and natural place, as they ſpeak, yet in autumn, if the weather be fair, the temperature of it will much vary in the compaſs of the ſame day, and the liquor will be much hotter at noon, than early in the morning, or at midnight; though this great diverſity be the effect only of a natural agent, the ſun, acting according to its regular courſe. And, in the depth of winter, it is generally confeſſed, that water is much colder, than in the heat of ſummer; which ſeems to be the reaſon of what is obſerved by watermen, as a wonderful thing, namely, that, in rivers, boats equally laden will not ſink ſo deep in winter, as in ſummer, the cold condenſing the water, and conſequently making it heavier in ſpecie, than it is in ſummer, when the heat of the ambient air makes it more thin. In divers parts of *Africk*, that temperature is thought natural to the water, becauſe it is that, which it uſually has, which is far hotter than that, which is thought natural to the ſame liquor in the frigid zone. And, I remember, on this occaſion, what perhaps I have elſewhere mentioned upon another, that the Ruſſian Czar's chief phyſician informed me, that in ſome parts of *Siberia*, (one of the more northern provinces of that monarch's empire, water is ſo much more cold, not only than in the torrid zone, but than in *England*, that two or three foot beneath the ſurface of the ground, all the year long (even in ſummer itſelf,) it continues concreted in the form of ice; ſo intenſe is the degree of cold, that there ſeems natural to it. This odd phænomenon much confirms, what I lately intimated of the power of contiguous bodies, and eſpecially of the air, to vary the degree of the coldneſs of water. I particularly mention the air, becauſe, as far as I have tried, it has more power to bring water to its own temperature, than is commonly ſuppoſed: for though, if, in ſummer-time, a man puts his hand into water, that has lain expoſed to the ſun, he will uſually feel it cold, and ſo conclude it much colder, than the ambient air; yet that may often happen upon another account, namely, that the water being many hundred times a more denſe fluid than the air, and conſiſting of particles more apt to inſinuate themſelves into the pores of the ſkin, a greater part of the agitation of the blood and ſpirits contained in the hand is communicated to the water, and thereby loſt by the fluids, that part with it: and the minute particles of the water, which are, perhaps, more ſupple and flexible, inſinuating themſelves into the pores of the ſkin, which the aerial particles, by reaſon of their ſtiffneſs, and perhaps length, cannot do; they come to affect the ſomewhat more internal parts of the hand, which, being much hotter, than the cuticula or ſcarf-ſkin, makes us feel them very cold; as, when a ſweating hand is plunged into luke-warm water, the liquor will be judged cold by him, who, if his other hand be very cold, will with it feel the ſame water hot. To confirm which conjecture I ſhall add, that having ſometimes purpoſely taken a ſealed weather-glaſs, whoſe included liquor was brought to the temperature of the ambient air, and thruſt the ball of it under water kept in the ſame air, there would be diſcovered no ſuch coldneſs in the water, as one would have expected; the former reaſon of the ſenſible cold the hand feels, when thruſt into that liquor, having here no place. To which I ſhall add, that having, for trial's ſake, made water very cold, by diſſolving ſal-armoniac in it, in ſummer-time, it would, after a while, return to its uſual degree of warmth; and having made the ſame experiment in winter, it would return to ſuch a coldneſs, as belonged to it in that ſeaſon: ſo that it did not return to any determinate degree of coldneſs, as natural to it, but to that greater or leſſer, that had been accidentally given it by the ambient air, before the ſal-armoniac had refrigerated it.

As to the motion of reſtitution, obſerved upon the removal or ceaſing of the force in air violently compreſſed, and in the blade of a ſword forcibly bent; I confeſs it ſeems to me a very difficult thing, to aſſign the true mechanical cauſe of it; but yet, I think it far more likely, that the cauſe ſhould be mechanical than, that the effect proceeds from ſuch a watchfulneſs of nature, as is pretended. For firſt, I queſtion, whether we have any air here below, that is in other than a preternatural or violent ſtate; the lower parts of our atmoſpherical air being conſtantly compreſſed by the weight of the upper parts of the ſame air, that lean upon them.

As for the reſtitution of the bent blade of a ſword, and ſuch like ſpringy bodies, when the force, that bent them, is removed; my thoughts about the theory of ſpringineſs belong to another paper. And therefore, I ſhall here only, by way of argument *ad hominem*, conſider, in anſwer to the objection, that if, for example, you take a ſomewhat long and narrow plate of ſilver, that has not been hammered, or compreſſed, or, which is ſurer, has been made red-hot in the fire, and ſuffered to cool leiſurely, you may bend it which way you will, and it will conſtantly retain the laſt curve figure, that you gave it: but if, having again ſtraightned this plate, you give it ſome ſmart ſtrokes of a hammer, it will, by that meerly mechanical change, become a ſpringy body; ſo that, if with your hand you force it a little from its rectitude, as ſoon as you remove your hand it will endeavour to regain its former ſtraightneſs. The like may be obſerved in copper, but nothing near ſo much, or ſcarce at all, in lead. Now, upon theſe phænomena, I demand, why, if nature be ſo careful to reſtore bodies to their former ſtate, ſhe does not reſtore the ſilver blade or plate to its rectitude, when it is bent this way or that way, before it is hammered? And why a few ſtrokes of a hammer (which, acting violently, ſeems likely to have put the metal into a preternatural ſtate,) ſhould entitle the blade to nature's peculiar care, and make her ſolicitous to reſtore it to its rectitude, when it is forced from it? And why, if the ſpringy plate be again ignited and refrigerated of itſelf, nature abandons her former care of it, and ſuffers it quietly to continue in what crooked poſture one pleaſes to put it into? Not, now, to demand a reaſon of nature's greater partiality to ſilver, and copper and iron, than to lead and gold itſelf, in reference to the motion of reſtitution; I ſhall add to what I was juſt now ſaying, that even in ſword-blades it has been often obſerved, that though, if ſoon after they are bent, the force, that bent them, be withdrawn, they will nimbly return to their former ſtraightneſs; yet, if they (which are not the only ſpringy bodies, of which this has been obſerved,) be kept too long bent, they will loſe the power of recovering ther former ſtraightneſs, and continue in that crooked poſture, though the force, that put them into it, ceaſe to act: ſo that, it ſeems, nature eaſily forgets the care ſhe was preſumed to take of it at firſt.

THERE is an axiom, that paſſes for current among learned men, *viz. nullum violentum durabile*, that ſeems much to favour the opinion of the naturiſts, ſince it is grounded upon a ſuppoſition, that what is violent is, as ſuch, contrary to nature, and, for that reaſon, cannot laſt long. And this trite ſentence is, by the ſchools and even ſome modern philoſophers, ſo particularly applied to local motion, that ſome of them have, not improbably, made it the characteriſtick token, whereby to diſtinguiſh natural motions from thoſe, that are not ſo; that the former are perpetual, or at leaſt very durable, whereas the latter, being continually checked more and more by the renitency of nature, do continually decay, and within no long time are ſuppreſſed or extinguiſhed: but, on this occaſion, I muſt crave leave to make the following reflections.

1. IT may be juſtly queſtioned upon

grounds laid down in another part of this eſſay, whether there be any motion among inanimate bodies, that deſerves to be called violent, in contradiſtinction to natural; ſince, among ſuch, all motions, where no intelligent ſpirit intervenes, are made according to catholic, and almoſt, if not more than almoſt, mechanical laws.

2. Methinks the Peripatetics, who are wont to be the moſt forward to employ this axiom, ſhould find but little reaſon to do ſo, if they conſider how unſuitable it is to their doctrine, that the vaſt body of the firmament and all the planetary orbs are, by the *primum mobile,* with a ſtupendous ſwiftneſs whirled about from Eaſt to Weſt in four and twenty hours, contrary to their natural tendency; and that this violent and rapid motion of their incomparably greater part of the univerſe has laſted as long as the world itſelf, that is, according to *Ariſtotle,* for innumerable ages.

3. We may obſerve here below, that the ebbing and flowing of the ſea, which is generally ſuppoſed to proceed either from the motion of the moon, or that of the terreſtrial globe, or ſome other external cauſe, has laſted for ſome thouſands of years, and probably will do ſo, as long as the preſent ſyſtem of our vortex ſhall continue. I conſider alſo, that the other great ocean, the atmoſphere, conſiſts of numberleſs myriads of corpuſcles, that are here below continually kept in a violent ſtate; ſince they are elaſtical bodies, whereof the lower are ſtill compreſſed by the weight of the higher. And to make a ſpring of a body, it is requiſite, that it be forcibly bent or ſtretched, and have ſuch a perpetual endeavour to fly open, or to ſhrink in, that it will not fail to do ſo, as ſoon as the external force that hindered it is removed. And as for the ſtate of inanimate bodies, I do not ſee, that their being or not being natural can be, with any certainty, concluded from their being or not being very durable. For, not to mention, that leaves, that wither in a few months, and even bloſſoms, that often fade and fall off in few days, are as well natural bodies, as the ſolid and durable trees, that bear them; it is obvious, that, whether we make the ſtate of fluidity, or that of congelation, to be that, which is natural to water, and the other that, which is violent; its change from one of thoſe ſtates into another, and even its return to its former ſtate, is oftentimes, at ſome ſeaſons, and in ſome places, made very ſpeedily, perhaps in an hour or leſs, by cauſes, that are acknowledged to be natural. And miſts, hail, whirlwinds, lightning, falling ſtars, to name no more, notwithſtanding their being natural bodies, are far from being laſting, eſpecially in compariſon of glaſs, wherein the ingredients, ſand and fixt ſalt, are brought together by great violence of fire. And the motion, that a thin plate, or ſlender wire, of this glaſs can exerciſe, to reſtore itſelf to its former poſition, when forcibly bent, is (in great part) a laſting effect of the ſame violence of the fire: and ſo is the moſt durable perſeverance of the indiſſolubleneſs of the alcaliſate ſalt, that is one of the two ingredients of glaſs, notwithſtanding its being very eaſily diſſoluble in water and other liquors, and not uneaſily even in the moiſt air itſelf.

There is a diſtinction of local motion into natural and violent, that is ſo generally received and uſed, both by philoſophers and phyſicians, that I think it deſerves to have ſpecial notice taken of it in this ſection; ſince it implicitely contains an argument for the exiſtence of the thing called nature, by ſuppoſing it ſo manifeſt a thing, as that an important diſtinction may juſtly be grounded on it.

This implyed objection, I confeſs, is ſomewhat difficult to clear; not for any great force, that is contained in it, but becauſe of the ambiguity of the terms, wherein the diſtinction is wont to be employed: for moſt men ſpeak of the propoſed diſtinction of motion in ſo obſcure or ſo uncertain a way, that it is not eaſy to know, what they mean by either of the members of it. But yet ſome there are, who endeavour to ſpeak intelligibly, (and for that are to be commended) and define natural motion to be that, whoſe principle is within the moving body itſelf; and violent motion that, which bodies are put into by an external agent or cauſe. And in regard theſe ſpeak more clearly than the reſt, I ſhall here principally conſider the lately mentioned diſtinction, in the ſenſe they give it. I ſay then, that even according to this explication, I am not ſatisfied with the diſtinction: for, whereas it is a principle received, and frequently employed by *Ariſtotle* and his followers, *Quicquid movetur ab alio movetur;* it ſeems, that, according to this axiom, all motion may be called violent, ſince it proceeds from an external agent: and indeed, according to the ſchool philoſophers, the motion of far the greateſt part of the viſible world, though this motion be moſt regular and laſting, muſt, according to the propoſed diſtinction, be reputed violent; ſince they aſſert, that the immenſe firmament itſelf, and all the planetary orbs, (in compariſon of which vaſt cœleſtial part of the world, the ſublunary part is little more than a phyſical point,) is perpetually (and againſt its native tendency,) hurried about the centre of the world once in twenty-four hours, by an external though inviſible agent, which they therefore call the *primum mobile.* And as for the criterion of natural motion, that its principle is within the moving body; it may be ſaid, that all bodies, once in the ſtate of actual motion, whatever cauſe firſt brought them to it, are moved by an internal principle: as for inſtance, an arrow, that actually flies in the air towards a mark, moves by ſome principle or other reſiding within itſelf; for it does not depend on the bow it was ſhot out of, ſince it would continue, though that were broken, or even annihilated; nor does it depend upon the medium, which more reſiſts than aſſiſts its progreſs, as might be eaſily ſhewn, if it were needful; and if we ſhould ſuppoſe the ambient air either to be annihilated, or (which in our caſe would be equivalent,) rendered incapable of either furthering or hindring its progreſs, I ſee not, why the motion of the arrow muſt neceſſarily ceaſe, ſince in this caſe there remains no medium to be penetrated, and on that account oppoſe its progreſs. When in a watch, that is wound up, the ſpring endeavours to unbend or diſplay itſelf; and when the ſtring of a drawn bow is broken or let go, the ſpring of the former, and the woody part of the latter, does each return to a leſs crooked line: and though theſe motions be occaſioned by the forcible acts of external agents, yet the watch, ſpring, and the bow, have in themſelves (for aught appears to thoſe I reaſon with,) an inward principle, by which they are moved, till they have attained their poſition. Some perhaps would add, that a ſquib, or a rocket, though an artificial body, ſeems, as well as a falling ſtar, to move from an internal principle: but I ſhall rather obſerve, that, on the other ſide, external agents are requiſite to many motions, that are acknowledged to be natural; as, to omit the germination and flouriſhing of divers plants, as onions, leeks, potatoes, *&c.* though hung up in the air, by the heat of the ſun in the ſpring; to paſs by this, I ſay, if in the pneumatical engine or air-pump you place divers inſects, as bees, flies, caterpillars, *&c.* and withdraw the common air from the receiver, they will lie moveleſs, as if they were dead, though it be for ſeveral hours, whilſt they are kept from enjoying the preſence of the air: but when the external air is permitted again to return upon them, they will preſently be revived, (as I have with pleaſure tried,) and be brought to move again, according to their reſpective kinds; as if a fly, for inſtance, reſembled a little windmill in this, that being moveleſs of itſelf, it required the action of the air to put its wings and other parts into motion. But to inſiſt no farther on theſe arguments *ad hominem*, we may conſider, that ſince motion does not eſſentially belong to matter, as diviſibility and impenetrableneſs are believed to do; the motions of all bodies, at leaſt at the beginning of things, and the motions of moſt bodies, the cauſes of whoſe motions we can diſcern, were impreſſed on them, either by an external immaterial agent, God; or by other portions of matter (which are alſo extrinſical impellers) acting on them.

And this occaſion invites me to obſerve, that though motion be deſervedly made one of the principal parts of *Ariſtotle*'s definition of nature, yet men are wont to call ſuch motions natural, as are very hard to diſtinguiſh from thoſe they call violent. Thus, when water falls down to the ground, they tell us, that this motion is natural to that liquor, as it is a heavy body; but when a man ſpurts up water out of his mouth into the air, they pronounce that motion, becauſe of its tendency upwards, to be contrary to nature. And yet when he draws water into his mouth, by ſucking it through a long pipe held perpendicularly, they will have this motion of the water, though directly upwards, to be not violent, but natural. So when a foot-ball, or blown bladder, being let fall upon a hard floor, rebounds up to a good height, the deſcent and aſcent are both ſaid to be natural motions, though the former tends towards the centre of the earth, and the latter recedes as far as it can do from it. And ſo if from a conſiderable height you let fall a ball of ſome cloſe wood, that yet is not too heavy, as oak or the like, into a deep veſſel of water, it will deſcend a great way in that liquor, by a natural motion; and yet its contrary motion upwards ought not to be eſteemed violent, ſince, according to the ſchools, being lighter in ſpecie than water, it is natural to it to affect its proper place, for which purpoſe it muſt aſcend to the top of the liquor, and lie afloat there; and yet it is from theſe tendencies to oppoſite points, (as the zenith and the nadir) that men are wont to judge many motions of bodies to be natural or violent.

Natura eſt Principium quoddam & Cauſa, cur id moveatur & quieſcat, in quo ineſt, &c. Ariſtot. Auſcult. l. ii. c. 1.

And indeed, ſince it muſt be indifferent to a lifeleſs and inſenſible body, to what place it is made to move, all its motions may in ſome reſpect be ſaid to be natural, and in another violent: for as very many bodies of viſible bulk are ſet a moving by external impellents, and on that ſcore their motions may be ſaid to be violent; ſo the generality of impelled bodies do move either upwards, downwards, *&c.* toward any part of the world, in what line or way ſoever they find their motion leaſt reſiſted; which impulſe and tendency being given by virtue of what they call the general laws of nature, the motion may be ſaid to be natural.

I might here take notice, that, according to the Epicurean hypotheſis, it need not at all be admitted, that motion muſt be produced by ſuch a principle, as the ſchoolmen's nature: for, according to that great and antient ſect of philoſophers, the atomiſts, every indiviſible corpuſcle has actual motion, or an inceſſant endeavour to change places, eſſentially belonging to it, as it is an atom; inſomuch that in no caſe it can be deprived of this property or power. And all ſenſible bodies being, according to theſe phyſiologers, but caſual concretions or coalitions of atoms, each of them needs no other principle of motion, than that unloſeable endeavour of the atoms, that compoſe it, and happen, on the account of circumſtances, to have the tendency of the more numerous, or at leaſt the predominant, corpuſcles determined one way: and to theſe I might add ſome other ſuch reflections. But I ſhall, in this place, ſay no more concerning motion, not only becauſe, even after having conſidered the differing definitions, that *Ariſtotle*, *Carteſius*, and ſome other philoſophers, have given of it, I take it to be too difficult a ſubject to be clearly explicated in few words; but becauſe the only occaſion I had to mention it here was to ſhew, that the vulgar diſtinction of it into natural and violent is not ſo clear and well grounded, as to oblige us to admit (what it ſuppoſes,) that there is ſuch a being, as the naturiſts aſſert.

I COME now to conſider the argument, that may be drawn in favour of the received notion of nature, from the critical evacuations, which happen at certain times in diſeaſes, and the ſtrange ſhifts, that nature ſometimes makes uſe of in them, to free herſelf from the noxious humours, that oppreſſed her.

THIS argument I willingly acknowledge to be very conſiderable: for we really ſee, that in continual fevers, eſpecially in hotter climates, there do uſually happen, at certain times of the diſeaſes, notable and critical commotions or conflicts, after which the morbific matter is diſpoſed of and diſcharged by ways ſtrange and ſurpriſing, to the great and ſpeedy relief of the patient, if not to his perfect cure; as may appear by many inſtances to be met with in the obſervations of phyſicians about fevers, pleuriſies, *&c.* Upon this account I take the argument drawn from criſis's to be much the weightieſt, that can be urged for the opinion, from which I diſſent; and therefore I ſhall employ the more words in clearing this important difficulty.

IN order to this I deſire it may be kept in mind, that I do not only acknowledge, but teach, that the body of a man is an incomparable engine, which the moſt wiſe author of things has ſo ſkilfully framed for laſting very many years, that if there were in it an intelligent principle of ſelf-preſervation, (as the naturiſts ſuppoſe there is) things would not, in moſt caſes, be better or otherwiſe managed, for the conſervation of the animal's life, than they generally are. So that the queſtion is not, whether there is a great deal of providence and wiſdom exerciſed in the criſis's of diſeaſes, but upon what account it is, that theſe appoſite things are performed? the univerſal opinion of phyſicians is, that it is that intelligent principle they call nature, which being ſolicitous for the welfare of the patient, and diſtreſſed by the quantity or hurtfulneſs of the morbific matter, watches her opportunity (eſpecially when it is concocted) to expel it haſtily out of the body, by the moſt ſafe and convenient ways, which, in the preſent condition of the patient, can be taken; and I, on the other ſide, attribute criſis's to the wiſdom and ordinary providence of God, exerting itſelf by the mechaniſm, partly of that great machine, the world, and partly of that ſmaller engine, the human body, as it is conſtituted in the patient's preſent circumſtance; and the reaſons, that hinder me, from acquieſcing in the general opinion of phyſicians about criſis's, are principally theſe.

FIRST, I obſerve, that criſis's, properly ſo called, do very ſeldom happen in other than fevers, and the like acute diſeaſes, where, according to the common courſe of things, the malady is terminated, in no long time, either by recovery, or death, or a change into ſome other diſeaſe: but chronical ſickneſſes, ſuch as coughs, dropſies, gouts, *&c.* unleſs they happen to be accompanied with feveriſh diſtempers, are not wont to have criſis's; which argues, that nature doth not make critical evacuations, upon the account of ſuch care and watchfulneſs, as phyſicians aſcribe them to; ſince ſhe neglects to employ ſo ſalutary an expedient in diſeaſes, that are oftentimes no leſs dangerous and mortal, than divers acute diſeaſes, which ſhe attempts to cure by criſis's.

NEXT I conſider, that critical evacuations may be procured by the bare mechaniſm of the body: for, by vertue of that, it will often happen, that the fibres, or motive organs of the ſtomach, bowels, and other parts, being diſtended or vellicated by the plenty or acrimony of the peccant matter, will, by that irritation, be brought to contract themſelves vigorouſly, and to throw out the matter, that offends the parts, either by the emunctories or common-ſhores of the body, or by whatever paſſages the proſcribed matter can be with more eaſe diſcharged. Thus, when ſome men find their ſtomachs burdened with a clog of meat or drink, they uſe to thruſt their fingers into their throats, and by that mechanical way provoke the ſtomach to diſburden itſelf of its offenſive load, without being beholden to nature's watchfulneſs for a criſis, which probably ſhe would not (at leaſt ſo ſeaſonably) attempt. And thus, whereas it is uſual enough for criſis's to be made in fevers by large hæmorrhages at the noſe, and ſometimes at other parts, which is aſcribed to nature's watchful ſolicitude for the patient's recovery; I muſt take leave to add, that it hath been divers times obſerved, that even after death large bleedings have ſucceeded at the noſe and other parts of the body; which ſhews, that ſuch excretions may be made by vertue of the ſtructure of it, and the turgeſcence and acrimony of the humours, without any deſign of nature to ſave the life of the patient already dead.

INDEED, if it did appear by experience, that all, or almoſt all, the criſis's of diſeaſes did either expel the morbific matter, or at leaſt notably relieve the patient, the critical attempts of nature would much favour the opinion men have conceived of her vigilance and conduct: but unwelcome inſtances daily ſhew, that as ſome criſis's are ſalutary, (as they call them) ſo others prove mortal; and among thoſe, that do not directly or preſently kill the patient, there are divers, that leave him in a worſe condition, than he was before. And therefore I wonder not, that phyſicians have thought themſelves obliged to lay down ſeveral circumſtances, as neceſſary requiſites of a laudable criſis, if any of which be wanting, it is not thought of the beſt kind; and if the contrary to ſome of them happen, it is to be judged either pernicious, or at leaſt hurtful. For, whereas there are two general ways ſuppoſed to be employed by nature in making criſis's, the one by expulſion of the peccant matter out of the body, and the other by the ſettling of the matter ſomewhere within it, neither of theſe two ways is conſtantly ſucceſsful.

And therefore experience hath obliged phyſicians to divide criſis's, not only into perfect, that fully determine the event of the diſeaſe, and imperfect, that do but alter it for the better or the worſe; but into ſalutary, that quite deliver the patient, and mortal, that deſtroy him. And to a perfect and ſalutary criſis ſome learned men require no leſs than ſix conditions; namely, that it be preceded by ſigns of coction of the peccant matter; that it be made by a manifeſt and ſufficiently copious excretion or tranſlation; that it be made upon a critical day, as the ſeventh, fourteenth, *&c.* that it leave no relicks behind it, that may endanger a relapſe; that it be made ſafely, that is, without dangerous ſymptoms; and laſtly, that it be ſuitable to the nature of the diſeaſe and the patient. By this it may appear, that it is no common thing to meet with a perfect and ſalutary criſis, ſo many laudable conditions muſt concur in it; and indeed nature doth uſually take up with but imperfectly good ones, and it were happy, if ſhe made not better, provided ſhe made no worſe. But it is found by ſad experience, that ſhe rouſes herſelf up to make a criſis, not only upon improper, and, as phyſicians call them, intercident days, ſuch as the third, fifth, ninth, *&c.* or upon thoſe they call empty or medicinal days, which ſeldom afford any criſis, and much ſeldomer a good one; but alſo when there appear not any ſigns of coction, or at leaſt of due coction, and by theſe unſeaſonable attempts weaken the patient, and increaſe the malady, or perhaps make it ſpeedily mortal. Nor will it juſtify nature, to ſay, with ſome learned phyſicians, that theſe attempts are accidentally brought on by the acrimony or importunity of the morbific matter, by which ſhe is provoked, before the time, to endeavour an expulſion of it: for if nature be indeed ſo prudent and watchful a guardian, as ſhe is thought, ſhe ought not to ſuffer herſelf to be provoked to act preposterouſly, and make furious attempts, that laviſh to no purpoſe, or worſe than no purpoſe, that little ſtrength the patient hath ſo much need of. And therefore phyſicians do oftentimes very well, when, to act agreeably to the dictates of prudence, they forget how much wiſdom they are wont to aſcribe to nature, and employ their beſt ſkill and remedies to ſuppreſs or moderate the inordinate motions, or the improper and profuſe evacuations, that irritated nature raſhly begins to make. And though the criſis's, that are made by a metaſtaſis of the peccant matter, or by lodging it in ſome particular part of the body, whether external or internal, be oftentimes, when they are not ſalutary, ſomewhat leſs hurtful, than thoſe, that are made by excretion: yet theſe do frequently, though perhaps more ſlowly, prove dangerous enough, producing ſometimes inward impoſthumes, and ſometimes external tumors, in parts, that are either noble by their functions, or by their ſituation, or connexion, or ſympathy with others, that are not to be without hazard or great inconvenience oppreſſed.

I know, that phyſicians make it a great argument of nature's providence and ſkill, that ſhe watches for the concoction of the peccant matter, before ſhe rouſes herſelf up to expell it by a criſis. What is to be meant by this coction of humours, (for it ought not to be confounded with the coction of the aliments) they are not wont ſo clearly to declare: but, as I underſtand it, when they ſay, that a portion of peccant matter is brought to coction, they mean, that it has acquired ſuch a diſpoſition, as makes it more fit, than before, to be ſeparated from the ſounder portion of the maſs of blood, or from the conſiſtent parts, to which it perhaps formerly adhered, and to be afterwards expelled out of the body. This may be partly exemplified by what happens in ſome recent colds, where the lungs are affected, in which we ſee, that after a few days the phlegm is made more fluid; and that which is lodged in the lungs, (not ſticking ſo faſt to the inſide of the *aſpera arteria*) is eaſily brought up by coughing, which could not diſlodge it before. And in fevers, that ſeparation in the urine, formerly cloudleſs, that phyſicians look upon as a good ſign of coction, ſeems to be produced by ſome part of the peccant matter, that, beginning to be ſeparated from the blood, mingles with the urine, and is not uſually diſtinguiſhed from it, whilſt this liquor is warm; but when it is grown cold, does, on the ſcore of its weight or texture, ſomewhat recede, and appear in a diſtinct form, as of a cloud, a ſediment, *&c.* But whatever they mean by coction, it is plain enough, by what hath been lately noted, that, on many occaſions, nature doth not wait for it, but unſeaſonably, and oftentimes dangerouſly, attempts to proſcribe the matter, that offends her, before it be duly prepared for expulſion.

I come now to that circumſtance of criſis's, that is thought the moſt wonderful, which is, that nature does oftentimes by very unuſual ways, and at unexpected places, diſcharge the matter, that offends her, and thereby either cures, or notably relieves the patient: and it muſt not be denied, that, in ſome caſes, the critical evacuations have ſomewhat of ſurpriſing in them; and I ſhall alſo readily grant, that, *N. B.* [Divine providence may expreſly interpoſe, not only in the infliction of diſeaſes by way of puniſhment, but in the removal of them in the way of mercy.] But ſetting aſide theſe extraordinary caſes, I think it not abſurd to conjecture, that the performances of nature, in common criſis's, may be probably referred, partly to the particular condition of the matter to be expelled, and partly, (and indeed principally) to ſome peculiar diſpoſition in the primitive fabric of ſome parts of the patient's body, or ſome unuſual change made in the conſtruction of theſe parts by the diſeaſe itſelf, or other accidents; which original or adventitious diſpoſition of the ſick man's body, not being viſible to us, at leaſt while he is alive, we are apt to aſcribe the unexpected accidents of a criſis, if it prove ſalutary, to the wonderful providence of nature; and, if it happen to be other than ſalutary, we are wont to overlook them. To illuſtrate this matter, we may conſider, that plentiful evacuations, procured by medicines, are a kind of artificial criſis's: we ſee, that ſome bodies are ſo conſtituted, that although the peccant humour, wrought on by the medicine, ought, as the phyſician thinks, to be expelled by ſiege, and indeed is wont to be ſo, in the generality of thoſe, that take that kind of medicine, as, for inſtance, rhubarb or ſenna; yet the peculiar diſpoſition of the patient's ſtomach will make that an emetick, which was intended to be, and regularly ſhould be, a cathartick. Nor does this conſtitution of the ſtomach equally regard all purging medicines; for the ſame ſtomach, that will reject them in form, for inſtance, of a potion, will quietly entertain them, being in the form of pills. And to this let me add, what we obſerve of the operation of mercury; which though, if it be duly prepared, it is uſually given to procure ſalivation, eſpecially to ſucculent bodies; yet there are ſome patients, wherein, inſtead of ſalivating, it will violently and dangerouſly work downwards, like a purge, or make ſome other unexpected evacuation. And I have ſeen a patient, who, though young and very fat, could not be brought to ſalivate, neither by the gentler ways, nor by turbith-mineral and other harſher medicines, though adminiſtered by very ſkilful phyſicians and chirurgeons. And this peculiarity may be as well contracted, as native: for ſome perſons, eſpecially after ſurfeits having been roughly dealt with, or at leaſt tired out with a medicine of this or that kind of form, will afterwards nauſeate and vomit up the like medicine, though in other bodies it be never ſo far from being emetick. We ſee alſo, that ſometimes ſudorific medicines, inſtead of procuring ſweat, prove briſkly diuretic, and ſometimes either purging or vomitive. From all this we may argue, that the qualities of the irritating matter, and much more the particular diſpoſition of the patient's body, may procure evacuations at unexpected places. I remember too, that, among the obſervations I have met with of famous phyſicians, there are inſtances of periodical and critical evacuations, at very inconvenient, as well as unuſual vents; as ſome women are recorded to have had their menſes ſometimes at the eyes, ſometimes at the navil, and ſometimes at the mouth; of which there ſeems no cauſe ſo probable, as ſome peculiar ſtructure, whether native or adventitious, of the internal parts concerned in that diſcharge; and of ſuch unuſual ſtructures anatomiſts muſt have ſeen many, ſince I myſelf have obſerved more than one or two. If theſe uncommon ways of diſpoſing of the morbific matter were always ſalutary to the patient, the argument grounded on them would have more weight: but though moſt men take notice of this ſort of criſis's but when they are lucky; yet an impartial obſerver ſhall often find, that ill-conditioned and hurtful criſis's may be made by unuſual and unexpected ways. And, in ſome tranſlations of the morbific matter to diſtant and nobler parts, perhaps it will be as difficult to ſhew, by what channels or known ways the matter paſſed from one to another, as it is to determine, how it was conducted to thoſe parts, at which it was the moſt happily vented.

In the foregoing diſcourſe about criſis's, there is, I confeſs, much of paradox; and it was unwillingly enough, that I made an excurſion, or in-road, into a ſubject, that has been looked upon as the phyſicians peculiar province. And you may remember, that not far from the beginning of this little book, I told you, that I was willing to decline meddling with other, than inanimate bodies; living ones being, as of a leſs ſimple ſort, ſo of a more intricate ſpeculation: which reflection will, I hope, excuſe me to you, if you find, that my propoſed brevity, or the difficulty of the ſubject, has had any great influence on what I write, about health, diſeaſes, and criſis's. And, as for the ſons of *Æſculapius*, it may be repreſented to them, in my favour, that, beſides that I have treated of ſickneſs and criſis's, rather as a phyſiologer than a phyſician, I could not leave them unconſidered, without being thought, if not to betray, at leaſt to be wanting to the cauſe I was to plead for.

If it ſhould be diſliked, that I make the phænomena of the merely corporeal part of the world, under which I compriſe the bodies of animals, though not the rational ſouls of men, to be too generally referred to laws mechanical; I hope you will remember, for me, ſeveral things diſperſed in this treatiſe, that may, when laid together, afford a ſufficient anſwer to this ſurmiſe; and particularly, that almoſt all the modern philoſophers, and among them divers eminent divines, ſcruple not to forſake the ſpread opinion, that the cœleſtial orbs were moved and guided by intelligences; and to explicate, by phyſical cauſes, the eclipſes of the ſun and moon, the production or apparition, and phænomena of comets, and other things, that the Romans, as well as other Heathens, both antient and modern, have aſcribed to the immediate agency of divine cauſes. This allows me to obſerve to you, that, ſince theſe modern naturaliſts and divines are wont to explicate the phænomena of the vaſt cœleſtial bodies, by their local motions, and the conſequences of them, they do, as well as I, endeavour to account for what happens in the incomparably greateſt part of the univerſe, by phyſico-mechanical principles and laws. And, even in the terreſtrial part of the world, which we men inhabit, moſt of the moderns, that have freed themſelves from the prejudices of the ſchools, do not ſtick to give ſtatical, hydroſtatical, and other mechanical explications of the aſcenſion of water in pumps, the detention of it in watering-pots, whoſe upper orifices are cloſed, and of other various phænomena, which were formerly unanimouſly aſcribed to nature's wonderful providence, expreſſed in her care to hinder a vacuum.

BUT perhaps you will think it fitter for me to provide againſt their cenſure, who will diſlike what I have written about criſis's, not becauſe I have aſcribed too much to merely phyſical cauſes, but (on the contrary) becauſe I do not ſtrictly confine myſelf to them: for I doubt, that if you ſhould ſhew theſe papers to ſome of your friends, that affect to be ſtrict naturaliſts, they will think it ſtrange, that in one of the clauſes in the foregoing diſcourſe about criſes's, (I mean, that, to which this mark [*N. B.*] is prefixed) I admit, that their events may ſometimes be varied by ſome peculiar interpoſition of God. But yet I own to you, that the clauſe, it is like they would take exceptions at, did not unawares ſlip from my pen; for it is my ſettled opinion, that divine prudence is often, at leaſt, converſant in a peculiar manner about the actions of men, and the things, that happen to them, or have a neceſſary connexion with the one or the other, or both. And though I think it probable, that in the conduct of that far greateſt part of the univerſe, which is merely corporeal, the wiſe Author of it does ſeldom manifeſtly procure a receſſion from the ſettled courſe of the univerſe, and eſpecially from the moſt catholic laws of motion; yet, where men, who are creatures, that he is pleaſed to endow with free wills, (at leaſt in reference to things not ſpiritual) are nearly and highly concerned; I think he has, not only ſometimes by thoſe ſignal and manifeſt interpoſitions, we call miracles, acted by a ſupernatural way, but, as the ſovereign Lord and Governor of the world, doth divers times, (and perhaps oftener than mere philoſophers imagine) give by the intervention of rational minds, as well united, as not united, to human bodies, divers ſuch determinations to the motion of parts in thoſe bodies, and of others, which may be affected by them, as by laws merely mechanical, thoſe parts of matter would not have had: by which motions, ſo determined, either ſalutary or fatal criſis's, and many other things, conducive to the welfare or detriment of men, are produced.

The fifth commandment, in Exodus xx.

THE interpoſition of divine Providence, in caſes of life and death, might be eaſily ſhewn to Chriſtians, out of divers paſſages of ſcripture, which expreſly propoſed long life as a reward to obedient children, and to other righteous perſons among the *Jews*, and threatens *bloody and deceitful men*, that they *ſhall not live out half their days*; and which relates, that a king of *Iſrael* had his diſeaſe made mortal by his impious recourſe to the falſe God of *Eckron*; and that upon *Hezekiah*'s prayers and tears, God was pleaſed to add fifteen years to his life, and grant a ſpecial benediction to an outward medicine, applied to his threatening ſore. To which paſſages divers may be added out of the new teſtament alſo, and eſpecially that of St. *James*, who exhorts the ſick to ſeek for recovery by prayer; and that of St. *Paul*, where, ſpeaking to the *Corinthians* of the unworthy receivers of the Euchariſt, he tells them, that, *For that cauſe, divers were become ſick and weak among them, and many alſo died.* But though the nature of this diſcourſe diſſuades me from employing here the authority of ſcripture, yet it allows me to obſerve, (what is conſiderable on this occaſion) that natural theology and right reaſon comport very well with our propoſed doctrine: for, as I lately intimated, and do more fully ſhew, in another paper*, God has left to the will of man the direction of many local motions, in the parts of his own body, and thereby of ſome others; though the mechanical laws, on which the ordinary courſe of things mainly depends, do not only regulate the motions of bodies, but the determinations too: and ſince man himſelf is vouchſafed a power to alter, in ſeveral caſes, the uſual courſe of things, it ſhould not ſeem incredible, that the latent interpoſition of men, or perhaps angels, or other cauſes unthought of by us, ſhould ſometimes be employed to the like purpoſes by God, who is not only the all-wiſe Maker, but the abſolute, and yet moſt juſt and benign Rector of the univerſe, and of men.

Pſalm v. 6.
Pſalm lv. 23.

2 Kings i. 16.
Iſa. xxxviii.

James v. 15.

1 Cor. xi. 30.

* A diſcourſe relating to miracles.

To conclude this excurſion, which I hope will not appear uſeleſs, that has been occaſioned by the diſcourſe of criſis's, I think it becomes a Chriſtian philoſopher, to admit, in general, that God doth ſometimes in a peculiar, though hidden way, interpoſe in the ordinary phænomena and events of criſis's; but yet that this is done ſo ſeldom, at leaſt in a way, that we can certainly diſcern, that we are not haſtily to have recourſe to an extraordinary providence, and much leſs to the ſtrange care and ſkill of that queſtioned being called nature, in this or that particular caſe, though perhaps unexpected, if it may be probably accounted for by mechanical laws, and the ordinary courſe of things.

AND here, though in a place leſs proper than I might have choſen, if I had timely remembered, I ſhall, both in reference to the extraordinary accidents, that ſometimes happen in criſis's, and more generally to the ſeemingly irregular phænomena of the univerſe, venture to offer you a notion, that perhaps you will not diſlike. I think then, that when we conſider the world, and the phyſical changes, that happen in it, with reference to the Divine Wiſdom and Providence, the arguments for the affirmative ought, in their kind, to have more force than thoſe for the negative. For it ſeems more allowable to argue a Providence, from the exquiſite ſtructure and ſymmetry of the mundane bodies, and the apt ſubordination and train of cauſes, than to infer from ſome phyſical anomalies, that things are not framed and adminiſtered by a wiſe Author and Rector: for the characters and impreſſions of wiſdom, that are conſpicuous in the curious fabrick and orderly train of things, can, with no probability, be referred to blind chance, but muſt be to a moſt intelligent and deſigning Agent. Whereas on the other hand, beſides that the anomalies, we ſpeak of, are incomparably fewer than thoſe things, which are regular, and are produced in an orderly way; beſides this, I ſay, the divine Maker of the univerſe, being a moſt free Agent, and having an intellect infinitely ſuperior to ours, may, in the production of ſeemingly irregular phænomena, have ends unknown to us, which even the anomalies may be very fit to compaſs.

THUS, when a man, not verſed in the mathematicks, looks upon a curious geographical globe, though as ſoon as he perceives, that the differing bigneſſes, and particular confines of kingdoms and provinces, and the apt ſituations, true diſtances and bearings of the cities and towns he knows by ſight or fame, be rightly ſet down; he cannot but conclude, from theſe impreſſes of art or ſkill, that this was the work of a deſigning artificer: but though he alſo ſees on the ſame globe ſeveral circles, as the tropicks, the zodiack, the meridians, *&c.* if he be a ſober man, he will not think, that theſe were made by chance only, becauſe he knows not the reaſons or uſes of them, or becauſe ſome of the lines, as thoſe curve lines the ſeamen call rhumbs, are not, like the other, circular, but do oddly, and, with a ſeeming irregularity, interſect them; but will rather think, that the artiſt, that had knowledge enough to repreſent the globe of the earth and waters, in a body not two feet in diameter, had alſo ſkill enough to draw thoſe lines, with ſome deſign worthy of the ſame ſkill, though not obvious to thoſe, that are unacquainted with his art.

I DID not incogitantly ſpeak of irregularities, as if they might ſometimes be but ſeeming ones: for I think it very poſſible, that an artificer of ſo vaſt a comprehenſion, and ſo piercing a ſight, as is the Maker of the world, might, in this great automaton of his, have ſo ordered things, that divers of them may appear to us, and, as it were, break out abruptly and unexpectedly, and at great diſtances of time or place from one another, and on ſuch accounts be thought irregular; which yet really have, both in his pre-ordination, and in the connection of their genuine cauſes, a reference, that would, if we diſcerned it, keep us from imputing it either to chance, or to nature's aberrations. To illuſtrate this a little, let us conſider, that if, when the Jeſuits, that firſt came into *China*, preſented a curious ſtriking watch to the king, he, that looked to it, had wound up the alarum ſo as to ſtrike a little after one; if, I ſay, this had been done, and that theſe Chineſes, that looked upon it as a living creature, or ſome European animal, would think, that when the index, pointing at two of the clock, likewiſe ſtruck the ſame hour, and ſo three, four, and on-ward, they would judge, that theſe noiſes were regularly produced, becauſe they (at equal intervals of time) heard them, and whenſoever the index pointed at an hour, and never but then; but when the alarum came unexpectedly to make a loud, confuſed, and more laſting noiſe, they could ſcarce avoid thinking, that the animal was ſick, or exceedingly diſordered: and yet the alarming noiſe, did as properly flow from the ſtructure of the little engine, and was as much deſigned by the manager of it, as thoſe ſounds of the clock, that appeared manifeſtly regular.

SECT. VII.

I PROCEED now to the ſixth and difficulteſt part of my taſk, which is to ſhew, that the moſt general and current effata and axioms concerning nature, that are wont to be employed in the writings of philoſophers, may have a fair account given of them, agreeably to the doctrine I have hitherto propoſed, though theſe axioms do ſome of them ſuppoſe, and others ſeem ſtrongly to ſupport the received notion of nature.

TO clear the way for the enſuing explications, I muſt deſire you to recall to mind the two cautions I have formerly offered you (in the fifth ſection) wherewith I would have the common doctrine, about the ends or deſigns of nature, to be underſtood or limited; and therefore I ſhall not here repeat, what I there ſaid, but only add in two words, that if thoſe, and ſome few other ſuch things, had been obſerved and duly conſidered, they might perhaps have prevented much of the obſcurity, and ſome of the errors, that relate to the notion of nature.

I HOPE you have not forgot, that the deſign of this paper was to examine the vulgar notion of nature, not to eſtabliſh a new one of my own. And indeed the ambiguity of the word is ſo great, (as hath in the ſecond ſection been made appear) and it is, even by learned men, frequently employed to ſignify ſuch different things; that, without enumerating and diſtinguiſhing its various acceptions, it were very unſafe to venture a giving a definition of it, and perhaps it were very impoſſible to give any, that would not be liable to cenſure. I ſhall not therefore here preſume to define a thing, of which I have not found a ſtated and ſettled notion ſo far agreed on amongſt men, but that I was obliged, out of *Ariſtotle* and others, to compile, in the fourth ſection, a collective repreſentation of the vulgarly received idea, or notion of nature; and afterwards to draw up, as well as I could, inſtead of an accurate definition, tolerable deſcriptions of what, on moſt occaſions, may be intelligibly meant by it. Wherefore, deſiring and preſuming, that you will retain in your mind, and, as occaſion ſhall require, apply, in the following part of this eſſay, the things already delivered in the fourth ſection, I will not trouble you with the repetition of them.

BUT before I deſcend to treat of the particular effata or ſentences, that are received concerning nature's actings, it may not be improper, nor uneful, to try, if we can clear the way, by conſidering in what ſenſe nature may, or may not, be ſaid to act at all. For, for aught I can clearly diſcern, whatſoever is performed in the merely material world, is really done by particular bodies, acting according to the laws of motion, reſt, *&c.* that are ſettled and maintained by God among things corporeal; in which hypotheſis nature ſeems rather a notional thing, than a true phyſical, and diſtinct or ſeparate efficient; ſuch as would be, in caſe *Ariſtotle*'s doctrine were true, one of thoſe intelligences, that he preſumed to be the movers of the cœleſtial orbs. But men do oftentimes expreſs themſelves ſo very ambiguouſly or intricately, when they ſay, that nature does this and that, or, that ſhe acts thus and thus, that it is ſcarce (if at all) poſſible to tranſlate their expreſſions into any forms of ſpeech, adequate to the original, and yet intelligible: for which reaſon, though I have in the ſection ſaid ſomething to the ſame purpoſe with what I am now to propoſe, yet the difficulty and weight of the ſubject makes me think it may be expedient, if not neceſſary, in this place ſomewhat more fully to declare what men do, or ſhould mean, when they ſpeak of nature's acting, or of a thing's being naturally done or performed, by giving their words and phraſes ſometimes one interpretation, and ſometimes another.

I. Sometimes, when it is ſaid, that nature does this or that; it is leſs proper to ſay, that it is done by nature, than, that it is done according to nature: ſo that nature is not to be looked on, as a diſtinct or ſeparate agent, but as a rule, or rather a ſyſtem of rules, according to which thoſe agents, and the bodies they work on, are, by the great Author of things, determined to act and ſuffer.

Thus, when water is raiſed in a ſucking-pump, it is ſaid, that nature makes the water aſcend after the ſucker, to prevent a vacuum; though in reality this aſcenſion is made, not by ſuch a ſeparate agent, as nature is fancied to be, but by the preſſure of the atmoſphere acting upon the water, according to ſtatical rules, or the laws of the æquilibrium of liquors, ſettled by God among fluids, whether viſible or pneumatical. So, when the ſtrict Peripateticks tell us, that all the viſible cœleſtial orbs, being by a motion, that they call violent, hurried about the earth every four and twenty hours, from eaſt to weſt, each of the planetary orbs has a natural motion, that is quite contrary, tending from the weſt to the eaſt; if they will ſpeak congruouſly to their maſter's doctrine, they muſt uſe the term natural in the ſenſe our obſervation gives it; ſince *Ariſtotle* will have the cœleſtial orbs to be moved by external or ſeparate agents, namely, ſpiritual intelligences. Our obſervation may be alſo illuſtrated by other forms of ſpeech, that are in uſe; as when it is ſaid, that the law takes care of infants and lunaticks, that their indiſcreet actions or omiſſions, ſhould not damnify their inheritances; and that the law hangs men for murder, but only burns them in the hand for ſome leſſer faults; of which phraſes the meaning is, that magiſtrates and other miniſters of juſtice, acting according to the law of the land, do the things mentioned. And it tends yet more directly to our purpoſe to take notice, that it is common to aſcribe to art thoſe things, that are really performed by artificers, according to the preſcriptions of the art; as when it is ſaid, that geometry (as the name imports) meaſures land, aſtrology foretels changes of weather, and other future accidents, architecture makes buildings, and chymiſtry prepares medicines.

II. Sometimes, when divers things, ſuch as the growth of trees, the maturation of fruits, *&c.* are ſaid to be performed by the courſe of nature, the meaning ought to be, that ſuch things will be brought to paſs by their proper and immediate cauſes, according to the wonted manner and ſeries or order of their actings. Thus it is ſaid, that by the courſe of nature the ſummer days are longer than thoſe of the winter; that, when the moon is in oppoſition to the ſun, (that is in the full moon) that part of her body, which reſpects the earth, is more enlightened than at the new moon, or at either of the quadratures; and laſtly, that when ſhe enters more or leſs into the conical ſhadow of the earth, ſhe ſuffers a total or a partial eclipſe: and yet theſe, and other illuſtrious phænomena, may be clearly explicated, without recourſe to any ſuch being as the Ariſtotelians nature, barely by conſidering the ſituations and wonted motions of the ſun or earth, and the moon, with reference to each other, and to the terreſtrial globe.

And here it may not be amiſs to take notice, that we may ſometimes uſefully diſtinguiſh between the laws of nature, more properly ſo called, and the cuſtom of nature, or, if you pleaſe, between the fundamental and general conſtitutions among bodily things, and the municipal laws, (if I may ſo call them) that belong to this or that particular ſort of bodies. As, to reſume and ſomewhat vary our inſtance drawn from water, when this falls to the ground, it may be ſaid to do ſo by virtue of the cuſtom of nature, it being almoſt conſtantly uſual for that liquor to tend downwards, and actually to fall down, if it be not hindered: but when water aſcends by ſuction in a pump, or other inſtrument, that motion, being contrary to that, which is wonted, is made in virtue of a more catholick law of nature, by which it is provided, that a greater preſſure, which in our caſe the water ſuffers from the weight of the incumbent air, ſhould ſurmount a leſſer, ſuch as is here the gravity of the water, that aſcends in the pump or pipe.

The two foregoing obſervations may be farther illuſtrated, by conſidering, in what ſenſe men ſpeak of things, which they call præter-natural, or elſe, contrary to nature: for divers, if not moſt of their expreſſions of this kind, argue, that nature is in them taken for the particular and ſubordinate, or, as it were, the municipal laws eſtabliſhed among bodies. Thus water, when it is intenſely hot, is ſaid to be in a preter-natural ſtate, becauſe it is in one, that it is not uſual to it, and, men think, doth not regularly belong to it; though the fire or ſun, that thus agitates it, and puts it into this ſtate, is confeſſed to be a natural agent, and is not thought to act otherwiſe, than according to nature. Thus, when a ſpring, forcibly bent, is conceived to be in a ſtate contrary to its nature, as is argued from its inceſſant endeavour to remove the compreſſing body; this ſtate, whether preter-natural, or contrary to nature, ſhould be thought ſuch, but in reference to the ſpringy body: for otherwiſe it is as agreeable to the grand laws, that obtain among things corporeal, that ſuch a ſpring ſhould remain bent by the degree of force, that actually keeps it ſo, as that it ſhould diſplay itſelf in ſpight of a leſs, or incompetent, degree of force. And to omit the ſix non-natural things ſo much ſpoken of by phyſicians, I muſt here take notice, that though a diſeaſe be generally reckoned as a preter-natural thing, or, as others carry the notion farther, a ſtate contrary to nature; yet that muſt be underſtood only with reference to what cuſtomarily happens to a human body: ſince exceſſively cold winds, and immoderate rains, and ſultry air, and other uſual cauſes of diſeaſes, are as natural agents, and act as agreeably to the catholick laws of the univerſe, when they produce diſeaſes, as when they condenſe the clouds into rain or ſnow, blow ſhips into their harbour, make rivers overflow, ripen corn and fruit, and do ſuch other things, whether they be hurtful or beneficial to men. And, upon a like account, when monſters are ſaid to be preter-natural things, the expreſſion is to be underſtood with regard to that particular ſpecies of bodies, from which the monſter does enormouſly deviate, though the cauſes, that produce that deviation, act but according to the general laws, whereby things corporeal are guided.

III. I DOUBT, whether I ſhould add, as a third remark, or as ſomewhat that is referrible to one or both of the two foregoing, that ſometimes, when it is ſaid, that nature performs this or that thing, we are not to conceive, that this thing is an effect really produced by other, than by proper phyſical cauſes or agents; but, in ſuch expreſſions, we are rather to look upon nature, either as a relative thing, or as a term employed to denote a notional thing, with reference whereunto phyſical cauſes are conſidered, as acting after ſome peculiar manner, whereby we may diſtinguiſh their operations from thoſe, that are produced by other agents, or perhaps by the ſame, conſidered as acting in another way. This, I think, may be illuſtrated by ſome other received expreſſions, or forms of ſpeech. As, when many of the antient, and ſome of the modern philoſophers, have ſaid, that things are brought fatally to paſs; they did not mean, that fate was a diſtinct and ſeparate agent, but only, that the phyſical cauſes performed the effect, as, in their actings, they had a neceſſary dependance upon one another, or an inviolable connexion, that linked them together. And on the other ſide, when men ſay, as they too frequently do, that fortune or chance, ἡ τυχὴ or τὸ αὐτόματον, (for *Ariſtotle* and his followers diſtinguiſh them, aſcribing to the former, what unexpectedly happens to deliberating or deſigning, and to the latter, what happens to inanimate or undeſigning beings) has done this or that; conſiderate philoſophers do not look upon fortune or chance as a true and diſtinct phyſical cauſe, but as a notional thing, that denotes, that the proper agents produced the effect without an intention to do ſo, (as I have more fully declared in the fourth ſection.)

Differunt autem fortuna et caſus, quia caſus latius patet. Quod enim a fortuna eſt, caſu eſt: hoc autem non omne eſt a fortuna. Ariſt. Auſcult. lib. ii. c. 4.

ONE may, for aught I know, without impertinence, refer to this our third obſervation, that many things are wont to be attributed to time; as, when we ſay, that time ripens ſome fruits, that are too early gathered; that it makes many things moulder and decay, (*tempus edax rerum*;) that it is the mother of truth; that it produces great alterations, both in the affairs of men, and in their diſpoſitions and their bodies: to omit many other vulgar expreſſions, which repreſent time as the cauſe of ſeveral things, whereof really it is but an adjunct or a concomitant of the effects, (however coincident with the ſucceſſive parts of time, and ſo, ſome way, related to it) being indeed produced by other agents, that are their true and proper efficients.

SOMETIMES likewiſe, when it is ſaid, that nature does this or that, we ought not to ſuppoſe, that the effect is produced by a diſtinct or ſeparate being; but, on ſuch occaſions, the word nature is to be conceived to ſignify a complex or convention of all the eſſential properties, or neceſſary qualities, that belong to a body of that ſpecies, whereof the real agent is, or to more bodies reſpectively, if more concur to the production of the effect. To this ſenſe we are to expound many of thoſe forms of ſpeech, that are wont to be employed, when phyſicians, or others, ſpeak of what nature does in reference to diſeaſes, or the cure of them. And, to give a right ſenſe to ſuch expreſſions, I conſider nature, not as a principal and diſtinct agent, but a kind of compounded accident, that is (as it were) made up of, or reſults from, the divers properties and qualities, that belong to the true agents. And, that the name of a compounded accident may not be ſtartled at, I ſhall, to explain what I mean by it, obſerve, that, as there are ſome qualities or accidents, that, at leaſt in compariſon of others, may be called ſimple, as roundneſs, ſtraightneſs, heat, gravity, &c. ſo there are others, that may be conceived as compounded, or made up of ſeveral qualities united in one ſubject: as, in divers pigments, greenneſs is made up of blue and yellow, exquiſitely mixed; beauty is made up of fit colours, taking features, juſt ſtature, fine ſhape, graceful motions, and ſome other accidents of the human body and its parts. And of this ſort of compounded accidents, I am apt to think, there are far more, than, at the firſt mention of them, one would imagine. And to this kind of beings, the expreſſions, that naturiſts do, on divers occaſions, employ, incline me to think, that, what is called nature has a great affinity, at leaſt in reference to thoſe occaſions. On which ſuppoſition one may conceive, that, as when it is ſaid, that health makes a man eat well, digeſt well, ſleep well, *&c.* conſidering men do not look upon health as a diſtinct and ſeparate cauſe of theſe effects; but as what we lately called a compounded accident, that is, a complex of all the real and genuine cauſes of good appetite, digeſtion, ſleep, *&c.* inſomuch that health is not ſo properly the cauſe of theſe, as their effect or reſult: ſo in divers things, that nature is ſaid to do, we need conceive no more, than that the effects are produced by phyſical bodies and qualities, or other proper cauſes; which, when we conſider as conſpiring, or rather concurring, to produce the ſame effect, by a compendious term we call nature.

BY theſe and the like ways of interpretation I thought fit to try, whether I could give an intelligible and commodious ſenſe to divers of the maxims or ſentences, and other forms of ſpeech, that are employed by thoſe, that, on many occaſions, in differing expreſſions, ſay, that nature does this or that, and acts thus and thus. But I confeſs, that to clear all thoſe ambiguous and unſkilfully framed axioms and phraſes, I found to be ſo intricate and difficult a taſk, that, for want of time, and perhaps too of patience, I grew weary before I had proſecuted it to the utmoſt: for which reaſon, though it is not improbable, that ſome light may be given in this dark ſubject, by what I have been now ſaying, (as immature and unfiniſhed, as it is) eſpecially if it be reflected on in conjunction with what hath been formerly delivered (in the fourth ſection) about nature, general and particular; yet I ſhall, at preſent, make but very little uſe of the things, that have been now ſaid, in expounding the axioms I am particularly to conſider in this ſeventh ſection; hoping, that I may, by the help of other mediums, diſpatch my work without them. And, to do it the more eaſily, I ſhall, without tying myſelf to the order, wherein they are marſhalled after the beginning of the fourth ſection, treat of them in the order, wherein I think their explications may give moſt light to one another, or in that, wherein the papers, that belonged to them, were retrieved.

THE firſt of the received axioms I ſhall conſider, is, that, which pronounces, that *omnis natura eſt conſervatrix ſui*; where, by the word nature, I ſuppoſe they underſtand a natural body, for otherwiſe I know not what they meant. Now this axiom eaſily admits of a twofold interpretation: for either it may ſignify no more, than that no one body does tend to its own deſtruction, that is, to deſtroy itſelf; or elſe, that in every body there is a principle called nature, upon whoſe ſcore the body is vigilant and induſtrious to preſerve its natural ſtate, and to defend itſelf from the violence and attempts of all other bodies, that oppugn it, or endeavour to deſtroy or harm it.

IN the former of theſe two ſenſes, the axiom may be admitted, without any prejudice to our doctrine: for ſince, according to our hypotheſis, inanimate bodies can have neither appetites, nor hatreds, nor deſigns, which are all of them affections, not of brute matter but of intelligent beings; I, that think inanimate bodies have no appetites at all, may eaſily grant, that they have not any to deſtroy themſelves.

BUT, according to the other ſenſe of the propoſed axiom, it will import, that every body has, within itſelf, a principle, whereby it does deſire, and with all its power endeavour, to compaſs its own preſervation; and both to do thoſe things, that tend thereunto, and oppoſe all endeavours, that outward agents, or internal diſtempers, may uſe in order to the deſtruction of it.

AND as this is the moſt vulgar ſenſe of this axiom, ſo it is chiefly in this ſenſe, that I am concerned to examine it.

I CONCEIVE then, that the moſt wiſe Creator of things did at firſt ſo frame the world, and ſettle ſuch laws of motion between the bodies, that, as parts, compoſe it, that by the aſſiſtance of his general concourſe, the parts of the univerſe, eſpecially thoſe, that are the greater and the more noble, are lodged in ſuch places, and furniſhed with ſuch powers, that by the help of his general providence, they may have their beings continued and maintained, as long and as far forth, as the courſe he thought fit to eſtabliſh, among other things corporeal, requires.

UPON this ſuppoſition, which is but a reaſonable one, there will appear no neceſſity to have any recourſe, for the preſervation of particular bodies, to ſuch an internal appetite and inbred knowledge in each of them, as our adverſaries preſume; ſince, by virtue of the original frame of things, and eſtabliſhed laws of motion, bodies are neceſſarily determined to act on ſuch occaſions, after the manner they would do, if they had really an aim at ſelf-preſervation: as you ſee, that if a blown bladder be compreſſed, and thereby the included air be forced out of its wonted dimenſions and figure, it will inceſſantly endeavour to throw off, and repel that, which offers violence unto it, and firſt diſplace that part of the compreſſing body, that it finds weakeſt; though in all this, there be no appetite in the air, (as I elſewhere ſhew,) no more than in the bladder, to that particular figure, to maintain itſelf in which it ſeems ſo concerned.

THUS, it is all one to a lump of dough, whether you make it into a round loaf, or a long roll, or a flat cake, or give it any other form; for whatever figure your hands or your inſtruments leave in it, that it will retain, without having any appetite to return to that, which it laſt had. So it is all one to a piece of wax, whether your ſeal imprints on it the figure of a wolf, or that of a lamb. And, for brevity's ſake, to paſs by the inſtances, that might be drawn from what happens to wood, and marble, and metals, as they are differently ſhaped by the ſtatuary's art and tools; I will only obſerve, that the mariner's needle, before it is excited, may have no particular propenſity to have reſpect to one part of Heaven, more than another; but when it has been duly touched upon a loadſtone, the flower-de-luce will be determined to regard the North, and the oppoſite extream the South: ſo that if the lilly be drawn aſide, towards the Eaſt or towards the Weſt, as ſoon as the force, that detained it, is removed, it will return to its former poſition, and never reſt until it regard the north. But in ſpight of this ſeeming affection of the lilly to that point of the horizon, yet, if the needle be duly touched upon the contrary pole of the ſame or another vigorous loadſtone, the lilly will preſently forget its former inclination, and regard the ſouthern part of Heaven; to which poſition, it will, as it were, ſpontaneouſly return, having been forced aſide towards the Eaſt, or towards the Weſt, if it be again left to its liberty. So that, though it formerly ſeemed ſo much to affect one point of heaven, yet it may, in a trice, be brought to have a ſtrong propenſity for the oppoſite: the lilly having, indeed, no inclination for one point of Heaven more than another, but reſting in that poſition, to which it was laſt determined by the prevalence of magnetical effluvia. And this example may ſerve to illuſtrate and confirm, what we have been lately ſaying in general.

II. ANOTHER received axiom concerning nature is, that ſhe never fails or miſſes of her ends, *Natura fine ſuo nunquam excidit*. This is a propoſition, whoſe ambiguity makes it uneaſy for me to deliver my ſenſe of it; but yet, to ſay ſomewhat, if by nature we here underſtand that being, that the ſchoolmen ſtyle *natura naturans*, I grant, or rather aſſert, that nature never miſſeth its end. For the omniſcient and almighty author of things, having once framed the world, and eſtabliſhed in it the laws of motion, which he conſtantly maintains, there can no irregularity, or anomaly, happen, eſpecially among the greater mundane bodies, that he did not from the beginning foreſee and think fit to permit, ſince they are but genuine conſequences of that order of things, that, at the beginning, he moſt wiſely inſtituted. As I have formerly declared in inſtances of the eclipſes of the ſun and moon; to which I could add others, as the inundations of *Nilus*, ſo neceſſary to the health and plenty of *Ægypt*. And though, on ſome ſpecial occaſions, this inſtituted order, either ſeemingly or really, has been violated, as when the ſun is ſaid to have ſtood ſtill in the days of *Joſhua*, and the *Red-Sea* to have divided itſelf to give free paſſage to the *Iſraelites* led by *Moſes*; yet theſe things having been rarely done, for weighty ends and purpoſes, by the peculiar intervention of the firſt cauſe, either guiding or over-ruling the propenſities and motions of ſecundary agents; it cannot be ſaid, that God is fruſtrated of his ends by theſe deſigned, though ſeeming exorbitances, by which he moſt wiſely and effectually accompliſhes them. But if by nature be meant ſuch a ſubordinate principle, as men are wont to underſtand by that name, I doubt the axiom is in many caſes falſe; for though it be true, as I have often ſaid, that the material world is ſo conſtituted, that, for the moſt part, things are brought to paſs by corporeal agents, as regularly, as if they deſigned the effects they produce, yet there are ſeveral caſes, wherein things happen quite otherwiſe.

THUS it is confeſſed, that when a woman is with child, the aim of nature is to produce a perfect or genuine human fœtus; and yet we often ſee, that nature widely miſſing her mark, inſtead of that, produces a monſter: and of this we have ſuch frequent inſtances, that whole volumes have been publiſhed, to recount and deſcribe theſe groſs and deformed aberrations of nature. We many times ſee, (and I have formerly noted,) that in fevers, and other acute diſeaſes, ſhe makes critical attempts upon improper days, and in theſe unſeaſonable attempts does not only for the moſt part miſs of her end, which is to cure the patient, but often brings him to a far worſe condition, than he was in before ſhe uſed thoſe miſcarrying endeavours. To this may be referred the cheats men put upon nature; as when, by grafting, the ſap, that nature raiſes with intention to feed the fruit of a white thorn, (for inſtance,) is by the gardener brought to nouriſh a fruit of quite another kind. So, when malſters make barley to ſprout, that germination, whereby nature intended to produce ſtalks and ears, is perverted to a far differing purpoſe, and ſhe deluded. And now, to annex ſome arguments, *ad hominem*, we are told, that nature makes every agent aim at aſſimulating the patient to itſelf, and that upon this account the fire aims at converting wood, and the other bodies it works on, into fire. But, if this be ſo, nature muſt often miſs of her end in chymical furnaces, where the flame does never turn the bricks, that it makes red-hot, into fire; nor the crucibles, nor the cupels, nor yet the gold and ſilver, that it throughly pervades, and brings to be of a colour, the ſame, or very near the ſame, with its own, and keeps in a very intenſe degree of heat, and in actual fuſion. And even when fire acts upon wood, there is but one part of it turned into fire, ſince, to ſay nothing of the ſoot and concreted ſmoke, the aſhes remain fixed and incombuſtible. And ſo, to add another inſtance *ad hominem*, when we are told, that nature makes water aſcend in ſucking-pumps, *ob fugam vacui*, ſhe muſt needs (as I formerly noted to another purpoſe,) miſs of her aim, when the pump exceeds five and thirty, or forty, foot in height; for then, though you pump never ſo much, and withdraw the air from the upper part of the engine, the water will not aſcend to the top; and conſequently will leave a cavity, for whoſe repleniſhing ſhe was ſuppoſed to have raiſed that liquor two or three and thirty foot.

III. Another of the celebrated axioms concerning nature, is, that ſhe always acts by the ſhorteſt or moſt compendious ways: *Natura ſemper agit per vias breviſſimas*. But this rule, as well as divers others, does, I think, require to be ſomewhat explained and limited, before it be admitted. For it is true, that, as I have frequently occaſion to inculcate, the omniſcient author of the univerſe has ſo framed it, that moſt of the parts of it act as regularly in order to the ends of it, as if they did it with deſign. But, ſince inanimate bodies, at leaſt, have no knowledge, it cannot reaſonably be ſuppoſed, that they moderate and vary their own actions, according to the exigency of particular circumſtances, wherewith they muſt of neceſſity be unacquainted; and therefore it were ſtrange, if there were not divers occurrences, wherein they are determined to act by other, than the ſhorteſt ways, that lead to particular ends, if thoſe other ways be more congruous to the general laws or cuſtoms eſtabliſhed among things corporeal. This I prove by inſtances taken from gravity itſelf, which is, perhaps, that quality, which of all others is moſt probably referred to an inbred power and propenſion: for it is true, that if a ſtone, or another heavy body, be let fall into the free air, it will take its courſe directly towards the centre of the earth; and, if it meet with an inclining plane, which puts it out of its way, it will not for all that loſe its tendency towards the centre, but run along that plane, by which means its tendency downwards is proſecuted, though not, as before, in a perpendicular line, yet in the ſhorteſt way it is permitted to take. Theſe obvious phænomena, I confeſs, agree very well with the vulgar axiom, and poſſibly were the chief things, that induced men to frame it. But now let us ſuppoſe, that a ſmall bullet of marble or ſteel, after having for a pretty ſpace fallen through the air, lights upon a pavement of marble, or ſome ſuch hard ſtone, that lies, as floors are wont to do, horizontal; in this caſe experience ſhews, (as was formerly noted on another occaſion) that the falling ſtone will rebound to a conſiderable height, (in proportion to that it fell from) and falling down again rebound the ſecond time, though not ſo high as before; and, in ſhort, rebound ſeveral times, before, by ſettling upon the floor, it approaches, as near as is permitted it, to the centre of heavy bodies: whereas, if nature did in all caſes act by the moſt compendious ways, this bullet ought not to rebound at all; but, as ſoon as it found, by the hardneſs of the floor, it could deſcend no lower, it ought to have reſted there, as in the neareſt place it could obtain to the centre of the earth, whence every rebound muſt neceſſarily remove it to a greater diſtance. And ſo likewiſe, when a pendulum, or bullet faſtened to the end of a ſtring, is ſo held, that the ſtring is (*præter propter*) perpendicular to the horizon, if it be thence let fall, it will not ſtop at the perpendicular line, or line of direction, which is ſuppoſed to reach from the nail or other prop, through the centre of the bullet to the centre of the earth, but will paſs beyond it, and vibrate or ſwing to and fro, until it have paſſed again and again the line of direction, for a great while before the bullet come to ſettle in it, though, whenever it removes out of it, towards either hand, it muſt really aſcend or move upwards, and ſo go further off from the centre of the earth, to which, it is pretended, its innate propenſity determines it to approach, as much and as ſoon as is poſſible. But this inſtance having been formerly touched upon, I ſhall now obſerve, to the ſame purpoſe, that having taken a good ſea-compaſs, [and the experiment ſucceeded with a naked, yet nicely poiſed, needle] and ſuffered the magnetick needle to reſt north and ſouth; if I held the proper pole of a good loadſtone at a convenient diſtance on the right or left hand of the lilly, this would be drawn aſide from the north point towards the eaſt or weſt, as I pleaſed; and then the loadſtone being removed quite away, the lilly of the needle would indeed return northward, but would not ſtop in the magnetic meridian, but paſs on divers degrees beyond it, and would thence return without ſtopping at the meridian line; and ſo would, by its vibrations, deſcribe many arches ſtill ſhorter and ſhorter, until at length it came to ſettle on it, and recover that poſition, which, if nature always acted by the moſt compendious ways, it ſhould have reſted at the firſt time, that by the removal of the loadſtone he had regained it. But the truth is, that at leaſt inanimate bodies acting without knowledge or deſign of their own, cannot ſtop or moderate their own action, but muſt neceſſarily move as they are determined by the Catholic laws of motion, according to which, in one caſe, the impetus, that the bullet acquires by falling, is more powerful to carry it on beyond the line of direction, than the action of the cauſes of gravity is to ſtop it, as ſoon as it comes to the neareſt place they can give it to the centre of the earth. And ſomething like this happens in levity, as well as gravity; for if you take an oblong and conveniently ſhaped piece of light wood, as firr or deal, and having thruſt or ſunk it to the bottom of a ſomewhat deep ſtagnant water, give it leave to aſcend; it will not only regain the ſurface of the water, where, by the laws of gravity, it ought to reſt, and did reſt before it was forced down, but it will paſs far beyond that ſurface, and in part, as it were, ſhoot itſelf up into the incumbent air, and then fall down again, and riſe a ſecond time, and perhaps much oftner, and fall again, before it come to ſettle in its due place, in which it is in an æquilibrium with the water, that endeavours to preſs it upwards.

Natura ſemper id facit quod eſt optimum eorum quæ fieri poſſunt. *Ariſt. de Cœlo.* lib. ii. c. 4. See alſo *Ariſt. de Gen.* lib. ii. cap. 10. § 22.

ANOTHER of the ſentences, that are generally received concerning nature, is, that ſhe always does what is beſt to be done: *Natura ſemper quod optimum eſt facit.* But of this it will not be ſafe for me to deliver my opinion, until I have endeavoured to remove the ambiguity of the words; for they eaſily admit of two different ſenſes, ſince they may ſignify, that nature in the whole univerſe does always that, which is beſt, for the conſervation of it in its preſent ſtate; or, that, in reference to each body in particular, nature does ſtill what is beſt, that is, what moſt conduces to the preſervation and welfare of that body. If the firſt of theſe ſenſes be pitched upon, the axiom will be leſs liable to exception: but then, I fear, it will be difficult to be poſitively made out by ſuch inſtances, as will prove, that nature acts otherwiſe than neceſſarily according to laws mechanical; and therefore, until I meet with ſuch proofs, I ſhall proceed to the other ſenſe, that may be given our axiom, which, though it be the moſt uſual, yet, I confeſs, I cannot admit, without it be both explained and limited. I readily grant, that the all-wiſe author of things corporeal has ſo framed the world, that moſt things happen in it, as if the particular bodies, that compoſe it, were watchful both for their own welfare and that of the univerſe. But I think withal, that particular bodies, at leaſt thoſe, that are inanimate, acting without either knowledge or deſign, their actions do not tend to what is beſt for them in their private capacities, any further than will comport with the general laws of motion, and the important cuſtoms eſtabliſhed among things corporeal: ſo that to conform to theſe, divers things are done, that are neither the beſt, nor ſo much as good, in reference to the welfare of particular bodies.

THESE ſentiments I am induced to take up, not only by the more ſpeculative conſiderations, that have been formerly diſcourſed of, and therefore ſhall not here be repeated, but by daily obſervations and obvious experience.

WE ſee oftentimes, that fruit-trees, eſpecially when they grow old, will for one ſeaſon be ſo overcharged with fruit, that ſoon after they decay and die; and even whilſt they flouriſh, the exceſſive weight of the too numerous fruits does not ſeldom break off the branches they grow upon, and thereby both hinders the maturity of the fruit, and haſtens the death of the tree: whereas this fatal profuſeneſs would have been prevented, if a wiſe nature, harboured in the plant, did, as is preſumed, ſolicitouſly intend his welfare.

WE ſee alſo in divers diſeaſes, and in the unſeaſonable and hurtful criſis's of fevers, how far what men call nature oftentimes is from doing that, which is beſt for the ſick man's preſervation. And indeed, (as hath been formerly noted on another occaſion,) in many diſeaſes, as bleedings, convulſions, cholera's, &c. a great part of the phyſician's work is to appeaſe the fury, and to correct the errors, of nature, which being, as it were, tranſported with a blind and impetuous paſſion, unſeaſonably produces thoſe dangerous diſorders in the body, that, if ſhe were wiſe and watchful of its welfare, ſhe would have been as careful to prevent, as the phyſicians to remedy them.

ADD to all this, that if nature be ſo provident and watchful for the good of men and other animals, and of that part of the world, wherein they live; how comes it to paſs, that from time to time, ſhe deſtroys ſuch multitudes of men and beaſts, by earthquakes, peſtilences, famine, and other anomalies? And how comes it ſo often to paſs in teeming women, that, perhaps by a fright, or a longing deſire, or the bare ſight of any outward object, nature ſuffers herſelf to be ſo diſordered, and is brought to forget her plaſtick ſkill ſo much, as, inſtead of well-formed infants, to produce hideous monſters, and thoſe oftentimes ſo miſhapen and ill-contrived, that not only themſelves are unfit to live one day, or perhaps one hour, but cannot come into the world without killing the mother, that bare them. Theſe and ſuch other anomalies, though (as I have elſewhere ſhewn,) they be not repugnant to the catholic laws of the univerſe, and may be accounted for in the doctrine of God's general providence; yet they would ſeem to be aberrations incongruous enough to the idea the ſchools give of nature, as of a being, that, according to the axiom hitherto conſidered, does always that which is beſt. But it is time, that we paſs from that to the examen of another.

THOUGH I have had occaſion to treat of vacuum in the fifth ſection, yet I muſt alſo ſay ſomething about it in this, becauſe I there conſidered it, but as it is employed by the Peripatetics and others, to ſhew the neceſſity of the principle they call nature. But now I am to treat of it, not ſo much as an argument to be confuted, as on the ſcore of its belonging to a (very plauſible) axiom to be conſidered; although I fear, that, by reaſon of the identity of the ſubject, (though conſidered in the fifth ſection, and here, to differing purpoſes) I ſhall ſcarce avoid ſaying ſomething or other, co-incident with what has been ſaid already.

V. THE word vacuum being ambiguous, and uſed in differing ſenſes, I think it requiſite, before I declare my opinion about the generally received axiom of the ſchools, that *natura vacuum horret*, (or, as ſome expreſs it, *abhorret à vacuo*) to premiſe the chief acceptions, in which I have obſerved the term vacuum to be made uſe of: for it has ſometimes a vulgar, and ſometimes a philoſophical or ſtrict, ſignification. In common ſpeech, to be empty, uſually denotes, not to be devoid of all body whatſoever, but of that body, that men ſuppoſe ſhould be in the thing ſpoken of, or of that, which it was framed or deſigned to contain; as when men ſay, that a purſe is empty, if there be no money in it; or a bladder, when the air is ſqueezed out; or a barrel, when either it has not been yet filled with liquor, or has had the wine or other drink drawn out of it. The word vacuum is alſo taken in another ſenſe by philoſophers, that ſpeak ſtrictly, when they mean by it a ſpace within the world, (for I here meddle not with the imaginary ſpaces of the ſchoolmen, beyond the bounds of the univerſe,) wherein there is not contained any body whatſoever. This diſtinction being premiſed, I ſhall inform you, that taking the word vacuum in the ſtrict ſenſe, though many, and, among them, ſome of my beſt friends, preſſed me to a declaration of my ſenſe about that famous controverſy, *an detur vacuum*, becauſe, they were pleaſed to ſuppoſe, I had made more trials, than others had done, about it; yet I have refuſed to declare myſelf, either *pro* or *contra*, in that diſpute: ſince the deciſion of the queſtion ſeems to depend upon the ſtating of the true notion of a body, whoſe eſſence the Carteſians affirm, and moſt other philoſophers deny, to conſiſt only in extenſion, according to the three dimenſions, length, breadth, and depth or thickneſs; for, if Mr. *Des Cartes*'s notion be admitted, it will be irrational to admit a vacuum, ſince any ſpace, that is pretended to be empty, muſt be acknowledged to have the three dimenſions, and conſequently all, that is neceſſary to eſſentiate a body: and all the experiments, that can be made with quickſilver, or the machina Boyliana, (as they call it,) or other inſtruments contrived for the like uſes, will be eluded by the Carteſians, who will ſay, that the ſpace deſerted by the mercury, or the air, is not empty, ſince it has length, breadth, and depth, but is filled by their materia ſubtilis, that is fine enough to get freely in and out of the pores of the glaſſes, as the effluvia of the loadſtone can do. But though, for theſe and other reaſons, I ſtill forbear (as I lately ſaid I have formerly done,) to declare either way in the controverſy about vacuum, yet I ſhall not ſtick to acknowledge, that I do not acquieſce in the axiom of the ſchools, that nature abhors a vacuum.

FOR, firſt, I conſider, that the chief, if not the only, reaſon, that moves the generality of philoſophers to believe, that nature abhors a vacuum, is, that in ſome caſes, as the aſcenſion of water in ſucking-pumps, &c. they obſerve, that there is an unuſual endeavour, and perhaps a forcible motion, in water and other bodies to oppoſe a vacuum. But I, that ſee nothing to be manifeſt here, ſave that ſome bodies, not devoid of weight, have a motion upwards, or otherwiſe differing from their uſual motions, (as in determination, ſwiftneſs, &c.) am not apt, without abſolute neceſſity, to abſcribe to inanimate and ſenſeleſs bodies, ſuch as water, air, &c. the appetites and hatreds, that belong to rational, or at leaſt to ſenſitive, beings; and therefore think it a ſufficient reaſon to decline employing ſuch improper cauſes, if, without them, the motions, wont to be aſcribed to them, can be accounted for.

2. IF the Carteſian notion of the eſſence of a body be admitted by us, as it is by many modern philoſophers and mathematicians, it can ſcarce be denied, but that nature does not produce theſe oftentimes great, and oftner irregular, efforts to hinder a vacuum; ſince it being impoſſible there ſhould be any, it were a fond thing to ſuppoſe, that nature, who is repreſented to us as a moſt wiſe agent, ſhould beſtir herſelf, and do extravagant feats, to prevent an impoſſible miſchief.

3. IF the atomical hypotheſis be admitted, it muſt be granted, not only that nature does not abhor a vacuum, but that a great part of the things ſhe does require it, ſince they are brought to paſs by local motion; and yet there are very many caſes, wherein, according to theſe philoſophers, the neceſſary motions of bodies cannot be performed, unleſs the corpuſcles, that lie in their way, have little empty ſpaces to retire, or be impelled into, when the body, that puſhes them, endeavours to diſplace them. So that the effatum, that nature abhors a vacuum, agrees with neither of the two great ſects of the modern philoſophers.

BUT, without inſiſting on the authority of either of them, I conſider, that, for aught appears by the phænomena employed to demonſtrate nature's abhorrency of a vacuum, it may be rational enough to think, either that nature does not abhor a vacuum, even when ſhe ſeems ſolicitous to hinder it; or, that ſhe has but a very moderate hatred of it, in that ſenſe, wherein the vulgar philoſophers take the word vacuum.

FOR if we conſider, that in almoſt all viſible bodies here below, and even in the atmoſpherical air itſelf, there is more or leſs of gravity or tendency towards the centre of our terraqueous globe, we may perceive, that there is no need, that nature ſhould diſquiet herſelf, and act irregularly, to hinder a vacuum; ſince, without her abhorrence of it, it may be prevented or repleniſhed, by her affecting to place all heavy bodies as near the centre of the earth, as heavier than they will permit. And even without any deſign of hers, not to ſay without her exiſtence, a vacuity will be as much oppoſed, as we really find it to be, by the gravity of moſt, if not of all, bodies here below, and the confluxibility of liquors and other fluids: for by vertue of their gravity, and the minuteneſs of their parts, they will be determined to inſinuate themſelves into and fill all the ſpaces, that they do not find already poſſeſſed by other bodies, either more ponderous in ſpecie than themſelves, or, by reaſon of their firmneſs of ſtructure, capable of reſiſting or hindring their deſcent. Agreeably to which notion we may obſerve, that, where there is no danger of a vacuum, bodies may move, as they do, when they are ſaid to endeavour its prevention: as if you would thruſt your fiſt deep into a pail full of ſand, and afterwards draw it out again, there will need nothing but the gravity of the ſand to make it fill up the greateſt part of the ſpace deſerted by your fiſt; and if the pail be repleniſhed, inſtead of ſand, with an aggregate of corpuſcles more minute and glib than the grains of ſand, as for inſtance, with quickſilver or with water; then the ſpace, deſerted by your hand, will be, at leaſt as to ſenſe, compleatly filled up by the corpuſcles of the liquor, which, by their gravity, minuteneſs, and the fluidity of the body they compoſe, are determined to repleniſh the ſpace deſerted by the hand, that was plunged into either of thoſe liquors. And I elſewhere ſhew, that if you take a pipe of glaſs, whoſe cavity is too narrow to let water and quickſilver paſs by one another in it; if, I ſay, you take ſuch a pipe, and having (by the help of ſuction) lodged a ſmall cylinder of mercury of about half an inch long in the lower part of it, you carefully ſtop the upper orifice with the pulp of your finger, the quickſilver will remain ſuſpended in the pipe: and if then you thruſt the quickſilver directly downwards into a ſomewhat deep glaſs, or other veſſel, full of water, till the quickſilver be depreſſed about a foot or more beneath the ſurface of the water; if then you take off your finger from the orifice of the pipe, which it ſtopt before, you ſhall immediately ſee the quickſilver aſcend ſwiftly five or ſix inches, and remain ſuſpended at this new ſtation. Which experiment ſeems manifeſtly to prove, what I did long ago deviſe and do now alledge it for; ſince here we have a ſudden aſcent of ſo heavy a body, as is quickſilver, and a ſuſpenſion of it in the glaſs, not produced to prevent or fill a vacuum, for the pipe was open at both ends, the phænomena being but genuine conſequences of the laws of the æquilibrium of liquors, as I elſewhere clearly and particularly declare,

When I conſider, how great a power the ſchool-philoſophers aſcribe to nature, I am the leſs inclined to think, that her abhorrence of a vacuum is ſo great, as they believed. For I have ſhewn in the fifth ſection, that her averſion from it, and her watchfulneſs againſt it, are not ſo great, but that, in the ſenſe of the Peripatetics, ſhe can quietly enough admit it in ſome caſes, where, with a very ſmall endeavour, ſhe might prevent or repleniſh it, as I have particularly manifeſted in the fore-cited ſection. I juſt now mentioned a vacuum in the ſenſe of the Peripatetics, becauſe when the Torricellian experiment is made, though it cannot, perhaps, be cogently proved, either againſt the Carteſians, or ſome other Pleniſts, that in the upper part of the tube deſerted by the quickſilver there is a vacuum, in the ſtrict philoſophical ſenſe of the word; yet as the Peripatetics declare their ſenſe by divers of their reaſonings againſt a vacuum mentioned in that ſection, it will to a heedful peruſer appear very hard for them to ſhew, that there is not one in that tube. And as by the ſchool-men's way of arguing nature's hatred of a vacuum from the ſuſpenſion of water and other liquors in tubes and conical watring-pots, it appears, that they thought, that any ſpace here below deſerted by a viſible body, not ſucceeded by another viſible body, or at leaſt by common air, may be reputed empty; ſo, by the ſpace deſerted by the quickſilver at the top of the pipe of a baroſcope thirty one inches long, one may be invited to doubt, whether a vacuum ought to be thought ſo formidable a thing to nature, as they imagine ſhe does, and ought to, think it? For what miſchief do we ſee enſue to the univerſe upon the producing or continuance of ſuch a vacuum, though the deſerted ſpace were many times greater than an inch, and continued many years, as has divers times happened in the taller ſort of mercurial baroſcopes? And thoſe Peripatetics, that tell us, that, if there were a vacuum, the influences of the cœleſtial bodies, that are abſolutely neceſſary to the preſervation of ſublunary ones, would be intercepted, ſince motion cannot be made in vacuo, would do well to prove, not ſuppoſe, ſuch a neceſſity; and alſo to conſider, that in our caſe the top of the quickſilver, to which the vacuum reaches, does uſually appear protuberant; which ſhews, that the beams of light (which they think of great affinity to influences, if not the vehicle,) are able to traverſe that vacuum, being in ſpight of it reflected from the mercury to the beholder's eye. And in ſuch a vacuum, as to common air, I have tried, that a load-ſtone will emit its effluvia, and move iron or ſteel placed in it. In ſhort, it is not evident, that here below nature ſo much ſtrains herſelf to hinder or fill up a vacuum, as to manifeſt an abhorrence of it. And without much peculiar ſolicitude, a vacuum, at leaſt a philoſophical one, is as much provided againſt, as the welfare of the univerſe requires, by gravity and confluxibility of the liquors and other bodies, that are placed here below. And as for thoſe, that tell us, that nature abhors and prevents a vacuum, as well in the upper part of the world as the lower, I think we need not trouble ourſelves to anſwer the allegation, till they have proved it: which I think will be very hard for them to do; not to mention, that a Carteſian may tell them, that it were as needleſs for nature to oppoſe a vacuum in heaven as in earth, ſince the production of it is every where alike impoſſible.

VI. I come now to the celebrated ſaying, that *natura eſt morborum medicatrix*, taken from *Hippocrates*, who expreſſes it in the plural, νουσῶν φυσιὲς ἰητροὶ. And becauſe this axiom is generally received among phyſicians and philoſophers, and ſeems to be one of the principal things, that has made them introduce ſuch a being, as they call nature, I think it may be time well employed, to conſider ſomewhat attentively, in what ſenſe, and how far, this famous ſentence, may, or ſhould not, be admitted.

Hippocrat. Epidem. *lib.* 6. §. 5. *t.* 1.

First then, I conceive it may be taken in a negative ſenſe, ſo as to import, that diſeaſes cannot be cured in ſuch perſons, in whom the aggregate of the vital powers or faculties of the body is ſo far weakened or depraved, as to be utterly unable to perform the functions neceſſary to life, or at leaſt to actuate and aſſiſt the remedies employed by the phyſician to preſerve or recover the patient. This I take to be the meaning of ſuch uſual phraſes, as, that phyſick comes too late, and that nature is quite ſpent: and in this ſenſe I readily acknowledge the axiom to be true; for, where the engine has ſome neceſſary parts, whether fluid or ſolid, ſo far depraved or weakned, as to render it altogether unable to co-operate with the medicine, it cannot be rationally expected, that the adminiſtration of that medicine ſhould be effectual; but in this, I preſume, there is no difficulty worthy to detain us. I proceed therefore to the poſitive ſenſe, whereof our axiom is capable, and wherein it is the moſt uſually employed: for men are wont to believe, that there reſides in the body of a ſick perſon a certain provident or watchful being, that ſtill induſtriouſly employs itſelf, by its own endeavours, as well as by any occaſional aſſiſtance, that may be afforded it by the phyſician, to rectify whatever is amiſs, and reſtore the diſtempered body to its priſtine ſtate of health. What I think of this doctrine I ſhall leave you to gather from the following diſcourſe.

I CONCEIVE then in the firſt place, that the wiſe and beneficent maker of the world and of man, intending, that men ſhould, for the moſt part, live a conſiderable number of years, in a condition to act their part on the mundane ſtage; he was pleaſed to frame thoſe living automata, human bodies, that, with the ordinary ſuccours of reaſon, making uſe of their exquiſite ſtructure fitted for durableneſs, and of the friendly, though undeſigned, aſſiſtance of the various bodies, among which they are placed, they may in many caſes recover a ſtate of health, if they chance to be put out of it by leſſer accidents than thoſe, that God, in compliance with the great ends of his general providence, did not think fit to ſecure them from, or enable them to ſurmount. Many things therefore, that are commonly aſcribed to nature, I think, may be better aſcribed to the mechaniſms of the macrocoſm and microcoſm, I mean, of the univerſe and the human body. And, to illuſtrate a little my meaning by a groſs example or two, I deſire you will conſider with me a ſea-compaſs, wherein the excited magnetick needle, and the box, that holds it, are duly poiſed by means of a competent number of oppoſite pivats: for though, if you give this inſtrument a ſomewhat rude ſhake, you will make the box totter, and encline this way and that way, and at the ſame time drive the points of the magnetick needle many degrees to the eaſt, or to the weſt; yet, the conſtruction of the inſtrument and the magnetiſm of one main part of it are ſuch, that if the force, that firſt put it into a diſorderly motion, ceaſe from acting on it, the box will, after ſome reciprocations, return to its horizontal ſituation; and the needle, that was forced to deviate, will, after a few irregular motions to this and to that ſide of the magnetical meridian, ſettle itſelf again in a poſition, wherein the flower-de-luce ſtedfaſtly regards the north. And yet this recovery to its former ſtate is effected in a factitious body, by the bare mechaniſm of the inſtrument itſelf, and of the earth, and other bodies, within whoſe ſphere of activity it is placed. But becauſe many have not ſeen a mariner's compaſs, I will add a leſs appoſite, but more obvious and familiar example: for if when an empty balance is duly counterpoiſed, you ſhall, by your breath or hand, depreſs one of the ſcales, and thereby, for the time, deſtroy the *Æquilibrium*; yet, when the force is once removed, the depreſſed balance will preſently aſcend, and the oppoſite will deſcend; and, after a few motions up and down, they will both of them, of their own accord, ſettle again in an exact *Æquilibrium*, without the help of any ſuch provident internal principle, as nature; the abſence of whoſe agency may be confirmed by this, that the depreſſed ſcale does not at firſt ſtop at the horizontal line, beneath which it was firſt depreſſed, (as it ought to do, if it were raiſed by an intelligent being,) but riſes far above it. If it be here objected, that theſe examples are drawn from factitious, not from merely phyſical bodies; I ſhall return this brief anſwer, and deſire, that it be applied not only to the two freſhly mentioned examples, but to all of the like kind, that may be met with in this whole treatiſe. I ſay then, in ſhort, that divers of the inſtances we are ſpeaking of are intended but for illuſtrations, and that others may be uſeful inſtances, if they ſhould be no more than analogous ones; ſince examples drawn from artificial bodies and things may have both the advantage of being more clearly conceived by ordinary underſtandings, and that of being leſs obnoxious to be queſtioned in that particular, in which the compariſon or correſpondence conſiſts: and I the leſs ſcruple to employ ſuch examples, becauſe *Ariſtotle* himſelf and ſome of his more learned followers make uſe of divers compariſons drawn from the figures and other accidents of artificial things, to give an account of phyſical ſubjects, and even of the generation, corruption, and forms of natural bodies. This advertiſement premiſed, I purſue this diſcourſe it interrupted, by adding, thus in a human body the cauſes, that diſorder it, are oftentimes but tranſient; whereas the ſtructure of the body itſelf, and the cauſes, that conduce to the preſervation of that ſtructure, are more ſtable and durable, and on that account may enable the engine to out-laſt many things, that are hoſtile to it. This may be ſomewhat illuſtrated, by conſidering, that ſleep, though it be not properly a diſeaſe, eaſily becomes one, when it frequently tranſgreſſeth its due bounds; and even whilſt it keeps within them, it does, for the time it laſts, hinder the exerciſe of many functions of the body more than ſeveral diſeaſes do; and yet, according to the common courſe of things, the matter, that locked up the ſenſes, being ſpent, the man of himſelf recovers that ſenſible and active ſtate, on whoſe ſcore he is ſaid to be awake. But to come ſomewhat cloſer to the point, we ſee, that many perſons, who get a preternatural thirſt with over-much drinking, get rid of it again in a few days by forbearing ſuch exceſſes; and many, that by too plentiful meals are brought to a want of appetite, recover, as it were, of courſe, by a ſpare diet, in a few days; the renewed ferment, or menſtruum of the ſtomach, being able in that time to concoct by little and little, or expel the indigeſted aliments or peccant humours, that offended the ſtomach, and cauſed the want of appetite.

And here I deſire to have it taken notice of, as a thing, that may be conſiderable to our preſent purpoſe, that I look not on a human body, as on a watch or a hand-mill, *i. e.* as a machine made up only of ſolid, or at leaſt conſiſtent parts; but as an hydraulical, or rather hydraulopneumatical engine, that conſiſts not only of ſolid and ſtable parts, but of fluids, and thoſe in organical motion; and not only ſo, but I conſider, that theſe fluids, the liquors and ſpirits, are in a living man ſo conſtituted, that in certain circumſtances the liquors are diſpoſed to be put into a fermentation or commotion, whereby either ſome depuration of themſelves, or ſome diſcharge of hurtful matter by excretion, or both, are produced, ſo as, for the moſt part, to conduce to the recovery or welfare of the body.

And that even conſiſtent parts may be ſo framed, and ſo connected with other parts, as to act, as it were, *pro re nata*, varying their motions, as differing circumſtances make it convenient they ſhould be varied, I purpoſely ſhew in another paper. To this I might altogether refer you; but, in regard the thing is a paradox, and lays a foundation for another not inferior to itſelf, I ſhall here borrow thence one inſtance, not mentioned that I know of by others to this purpoſe, that may both declare my meaning, and confirm the thing itſelf. I conſider then, that what is called the pupil or apple of the eye, is not (as it is known,) a ſubſtantial part of the organ, but only a round hole or window made in the uvea, at which the modified beams of light enter, to fall upon the chryſtalline humour, and thence be refracted to the bottom of the eye, or ſeat of viſion, to make there an impreſſion, that is uſually a kind of picture (for it is not always a neat one,) of the object. Now the wiſe and all-foreſeeing author of things has ſo admirably contrived this inſtrument of ſight, that, as it happens to be employed in differing lights, ſo the bigneſs or area of the pupil varies; for when the light is vivid, and would be too great, if all the beams were let in, that might enter at an aperture as large as the uſual, the curtain is every way drawn towards the middle, and thereby the round window made narrower; and, on the other ſide, when the light is but faint, and the object but dimly illuſtrated, there being more light requiſite to make a ſufficient impreſſion at the bottom of the eye, the curtain is every way drawn open, to let in more light; and when the eye is well conſtituted, this is regularly done, according as the organ has need of more or leſs light. Of this ſome late maſters of opticks have well treated, and I have ſpoken about it more fully in another place. And the truth of the obſervation you may eaſily find, if you look upon the eyes of a boy or a girl, (for in young perſons the change is the moſt notable) when the eyes are turned from looking on dark objects towards bright or more illuminated ones. And I have found the variation yet more conſpicuous in the eyes of a young cat, as I elſewhere particularly relate. So that, referring you to the writings already pointed at, I ſhall only add in this place, that theſe various motions in the eye are produced by mere mechaniſm, without the direction, or ſo much as knowledge or perception, of the rational ſoul. And, upon the like account it is, that other motions, in ſeveral parts belonging to the eye, are produced, as it were ſpontaneouſly, as occaſion requires. And ſo, as to the fluid parts of the body, we find, that, according to the inſtitution of the author of things, when healthy women are of a fit age, there is a monthly fermentation or commotion made in the blood, which uſually produces a kind of ſeparation, and then an excretion, advantageous to the body.

And that you may the better make out what I meant by the diſpoſition, or tendency, of the parts, to return to their former conſtitution, I ſhall deſire you to conſider, with me, a thin and narrow plate of good ſteel, or refined ſilver; for, if one end of it be forcibly drawn aſide, the changed texture of the parts becomes ſuch, or the congruity and incongruity of the pores, in reference to the ambient æther, that endeavours to permeate them, is made ſuch, that, as ſoon as the force, that bent it, is removed, the plate does, as it were, ſpontaneouſly return to its former poſition: and yet here is no internal watchful principle, that is ſolicitous to make this reſtitution, for otherwiſe it is indifferent to the plate what figure it ſettle in; for, if the ſpringy body ſtand long bent, then, as if nature forgot her office, or were unable to execute it, though the force, that held the ſpring bent, be removed, it will not endeavour to regain its former ſtraightneſs. And I have tried in a ſilver plate, that if you only heat it red-hot, and let it cool, if you put it into a crooked poſture, it will retain it; but barely with two or three ſtrokes of a hammer, which can only make an inviſible change of texture, the plate will acquire a manifeſt and conſiderable ſpringyneſs, which you may again deprive it of, by ſufficiently heating it in the fire, without ſo much as melting it.

BUT, to return to the diſcourſe, formerly begun, about diſtempers wont to be harmleſs by being tranſient, we may obſerve, that the third or fourth day after women are brought to bed there is commonly a kind of fever produced, upon the plentiful reſort of the milk to the breaſts; for which cauſe, this diſtemper is, by many, called the fever of milk; and this is wont, in a ſhort time, to paſs away of itſelf, as depending upon cauſes far leſs durable, than the oeconomy of the woman's body. And if it be objected, that theſe are not diſeaſes, becauſe they happen according to the inſtituted courſe of nature; I will not now diſpute the validity of the conſequence, though I could repreſent, that the labour of teeming women, and the breeding of teeth in children, happen as much according to the inſtitution of nature, and yet are uſually very painful, and oftentimes dangerous; but I will rather anſwer, that if the troubleſome accidents, I have alledged, cannot ſerve to prove, they may at leaſt to illuſtrate, what I aim at. And I ſhall proceed to take notice of a diſtemper, that phyſicians generally reckon among diſeaſes, I mean the flowing of blood at the hæmorrhoidal veins: for, though oftentimes this flux of blood is exceſſive, and ſo becomes very dangerous, and therefore muſt be checked by the phyſician, (which is no great argument, that a being, wiſe and watchful, manages this evacuation;) yet frequently, if not for the moſt part, the conſtitution of the body is ſuch, that the ſuperfluous or vitiated blood goes off, before it has been able to do any conſiderable miſchief, or perhaps any at all, to the body. And ſo we ſee, that many coughs, and hoarſeneſſes, and coryzas are ſaid to be cured, that is, do ceaſe to trouble men, though no medicine be uſed againſt them, the ſtructure of the body being durable enough to out-laſt the peccant matters, or the operation of thoſe other cauſes, that produce theſe diſtempers.

IT is a known thing, that moſt perſons, the firſt time they go to ſea, eſpecially if the weather be any thing ſtormy, are, by the unwonted agitations, which thoſe of the ſhip produce in them, (aſſiſted perhaps by the ſea-air, and ſmells of the ſhip) caſt into that diſeaſe, that, from the cauſe of it, is called the ſea-ſickneſs, which is ſometimes dangerous, and always very troubleſome, uſually cauſing a loſs of appetite, and almoſt continual faintneſs, a pain in the head, and almoſt conſtant nauſeouſneſs, accompanied with frequent, and oftentimes violent vomitings; which ſymptoms make many complain, that, for the time, they never felt ſo troubleſome a ſickneſs; and yet uſually, after not many days, this diſtemper, by degrees, is maſtered by the powers of the body, tending ſtill to perſevere in their orderly and friendly courſe, and ſuppreſſing the adventitious motions, that oppoſe it, and the ſick perſon recovers without other help. And ſo, though perſons unaccuſtomed to the ſea, whether they be ſick or no, are, by the inconvenient motions of the ſhip, uſually brought to a kind of habitual giddineſs, which diſpoſes them to reel and falter, when they walk upon firm ground; yet, when they come a ſhore, they are wont in no long time to be freed from this uneaſy giddineſs, without the help of any medicine; the uſual and regular motions of the parts of the body obliterating by degrees in a few days (I uſed to be free from it within ſome hours,) that adventitious impreſſion, that cauſed the diſcompoſure. To the ſame purpoſe we may take notice of that, which happens to many perſons, who riding backwards in a coach are not only much diſtempered in their heads, but are made very ſick in their ſtomachs, and forced to vomit, as violently and frequently, as if they had taken an emetick; and yet all this diſorder is wont quickly to ceaſe, when the patient leaves the coach, without the continuance of whoſe motion, (that continues a prepoſterous one in ſome parts of the patient) the diſtemper will quickly yield to the more ordinary and regular motions of the blood, and other fluids of the body. So, when in a coach, or elſewhere, a man happens to be brought to faintneſs, or caſt into a ſwoon, by the cloſeneſs of the place, or the over-charging of the air with the fuliginous reeks of men's bodies; though the diſeaſe be formidable, yet, if the patient be ſeaſonably brought into the free air, the friendly operation of that external body, aſſiſting the uſual endeavours or tendency of the parts of the patient's body to maintain his life and health, is wont quickly to reſtore him to the ſtate he was in before this ſudden ſickneſs invaded him. Divers things, that happen in ſome diſeaſes, may be groſly illuſtrated, by ſuppoſing, that into a vial of fair water ſome mud be put, and then the vial be well ſhaken, for the water will be troubled and dirty, and will loſe its tranſparency, upon a double account; that of the mud, whoſe opacous particles are confounded with it; and that of the newly generated bubbles, that ſwim at the top of it: and yet to clarify this water, and make it recover its former limpidneſs, there needs no particular care or deſign of nature, but, according to the common courſe of things, after ſome time the bubbles will break and vaniſh at the top, and the earthy particles, that compoſe the mud, will, by their gravity, ſubſide to the bottom, and ſettle there, and ſo the water will become clear again. Thus alſo muſt, which is the lately expreſſed juice of grapes, will for a good while continue a troubled liquor; but though there be no ſubſtantial form to guide the motions of this factitious body, yet, according to the courſe of things, a fermentation is excited, and ſome corpuſcles are driven away in the form of exhalations or vapours, others are thrown againſt the ſides of the caſk, and hardened there into tartar, and others again ſubſide to the bottom, and ſettle there in the form of lees; and by this means leave the liquor clear, and, as to ſenſe, uniform. And why may not ſome depurations and proſcriptions of heterogenous parts be made in the blood, as well as they are uſually in muſt, without any peculiar and ſolicitous direction of nature?

THERE is indeed one thing, to which the ſentence of nature's being the curer of diſeaſes may be very ſpeciouſly applied, and that is the healing of cuts and wounds, which, if they be but in the fleſh, may oftentimes be cured without plaiſters, ſalves, or other medicines; but, not to mention hæmorrhages and ſome other ſymptoms, wherein the chirurgeon is fain to curb or remedy the exorbitancies of nature, this healing of the *ſolutio continui* ſeems to be but an effect or conſequent of that fabrick of the body, on which nutrition depends: for the alimental juice, being, by the circulation of the blood and chyle, carried to all parts of the body to be nouriſhed, if it meets any where either with preternatural concretions, or with a gap made by a cut or wound, its particles do there concrete into a kind of baſtard-fleſh, or ſome ſuch other body, which that juice, in the place and other circumſtances it is in, is fitted to conſtitute. Thus we ſee, that not only wens and ſcrophulous tumors are nouriſhed in the body, but miſ-ſhapen mola's do by nutriment grow in the womb, as well as embryo's feed there. And, to come cloſer to the preſent argument, we ſee, that in wounds proud-fleſh, and perhaps fungus's, are as well produced and entertained by the aliment brought to the wounded part, as the true and genuine fleſh; ſo that either nature ſeems much miſtaken, if ſhe deſigns the production and maintenance of ſuch ſuperfluous and inconvenient bodies; or the chirurgeon is much to blame, who is induſtrious to deſtroy them, though oftentimes he cannot do it, without uſing painful corroſives. But, for aught appears, nature is not ſo ſhy and reſerved in her bounty, but that ſhe ſends nouriſhment to repair as well things, that do not belong to the body, as genuine parts of it, as to reſtore fleſh to wounded parts; as may appear by warts and corns, that grow again after they are ſkilfully cut. And I remember I have ſeen a woman, in whoſe forehead nature was careful to nouriſh a horn about an inch and more in length, which I fully examined, whilſt it was yet growing upon her head, to avoid being impoſed upon.

BUT, beſides the diſeaſes hitherto diſcourſed, there are many others, as well acute as chronical, wherein, it is confeſſed, that nature alone does not work the cure; ſo that as to theſe, (which are more numerous, than the former) I may well pretend, that the aphoriſm, that makes nature the curer of diſeaſes, is not true, otherwiſe than in a limited ſenſe. But becauſe I know it is pretended, that even in theſe diſeaſes nature is the principal agent, by whoſe direction the phyſician acts in ſubſerviency to her deſigns, and phyſicians themſelves (whether out of modeſty or inadvertence, I now inquire not,) are wont to acknowledge, that they are but nature's miniſters; I think it neceſſary to conſider briefly, what ſenſe is fit, according to our doctrine, to be given to theſe aſſertions, to make them receivable by us.

BUT, to make way for what we are to ſay on this occaſion, it may be fit to obſerve, that one great cauſe of the common miſtakes about this matter is, as hath been partly intimated already, that the body of a man is looked upon, rather as a ſyſtem of parts, whereof moſt are groſs and conſiſtent, and not a few hard and ſolid too, than as, what indeed it is, a very compounded engine, that, beſides theſe conſiſtent parts, does conſiſt of the blood, chyle, gall, and other liquors, alſo of more ſubtil fluids, as ſpirits and air; all which liquors and fluids are almoſt inceſſantly and variouſly moving, and thereby put divers of the ſolid parts, as the heart and lungs, the diaphragma, the hands, feet, *&c.* into frequent and differing motions: ſo that, as, when the conſtitution or the motions, that in a ſound body do regularly belong to the fluid parts, happens the former to be depraved, or the latter to grow anomalous, the engine is immediately out of order, though the groſs ſolid parts were not primarily affected; ſo, when by proper remedies (whether viſible or not,) the vitiated texture or craſis of the blood or other juices is corrected, and the inordinate motions, that they and the ſpirits are put into, or, that they alſo put the conſiſtent parts into, are calmed and rectified, the groſſer and more ſolid parts of the body, and ſo the whole animal oeconomy, if I may ſo call it, will be reſtored to a more convenient ſtate. Thus we ſee, that in many hyſtericall women, by the fragrant effluvia of a *Spaniſh* glove, or ſome other ſtrong perfume, the ſpirits and *genus nervoſum* being affected, ſeveral diſorderly ſymptoms are produced, and oftentimes the motion of the blood is ſo ſtopt and abated, that any pulſe at all is ſcarcely to be felt, nor reſpiration diſcerned, and the whole engine, unable to ſuſtain itſelf, falls to the ground, and lies moveleſs on it; and yet we have often, by barely holding to the patient's noſtrils a vial full of very ſtrong ſpirit, or volatile ſalt, or ſal-armoniac, or of hartſhorn, in leſs than a quarter of an hour, ſometimes in a few minutes, reſtored women in that condition to their ſenſes, ſpeech and motion.

WE are alſo here to conſider, what I have formerly inculcated, that the oeconomy of the human body is ſo conſtituted by the divine author of it, that it is uſually fitted to laſt many years, if the more general laws, ſettled by the ſame author of the univerſe, will permit it: and therefore it is not to be wondered at, that in many caſes the automaton ſhould be in a condition to concur, though not with knowledge and deſign, to its own preſervation, when, though it had been put ſomewhat out of order, it is aſſiſted by the phyſician's hands or medicines to recover a convenient ſtate.

AND if it be objected, that the examples, that have been in this paſt diſcourſe frequently drawn from automata, are not adequate, and do not fully reach the difficulties we have been ſpeaking of, I ſhall readily grant it, provided it be conſidered, that I avowedly and deſervedly ſuppoſe the bodies of living animals to be, originally, engines of God's own framing, and conſequently effects of an omniſcient and almighty artificer. So that, it is not rational to expect, that in the incomparably inferior productions of human ſkill, there ſhould be found engines fit to be compared with theſe, which, in their Protoplaſts, had God for their author. Not to mention, (what yet may be conſiderable in reference to the laſtingneſs of human life, (that a man is not a mere mechanical thing, where nothing is performed for the preſervation of the engine, of its recovery to a good ſtate, but by its own parts, or other agents, acting according to mechanical laws without counſel or deſign; ſince, though the body of a man be indeed an engine, yet there is united to it an intelligent being, (the rational ſoul or mind,) which is capable, eſpecially if inſtructed by the phyſician's art, to diſcern, in many caſes, what may hurt it, and what may conduce to the welfare of it, and is alſo able (by the power it has to govern the muſcles and other inſtruments of voluntary motion,) to do many of thoſe things it judges moſt conducive to the welfare and ſafety of the body, it is joined with. So that a man is not like a watch, or an empty boat, where there is nothing but what is purely mechanical; but like a mann'd boat, where, beſides the mechanical part, (if I may ſo ſpeak) there is an intelligent being, that takes care of it, and both ſteers it, or otherwiſe guides it, and when needs requires, trims it; and, in a word, as occaſion ſerves, does what he can to preſerve it, and keep it fit for the purpoſes it is deſigned for.

THESE things being premiſed, I think the phyſician (here ſuppoſed to be free from prejudices and miſtakes,) is to look upon his patient's body, as an engine, that is out of order, but yet is ſo conſtituted, that, by his concurrence with the endeavours, or rather tendencies, of the parts of the automaton itſelf, it may be brought to a better ſtate. If therefore he find, that in the preſent diſpoſition of the body there is a propenſity or tendency to throw off the matter, that offends it, and (which ought to be ſome way or other expelled,) in a convenient way, and at commodious places; he will then act ſo, as to comply with, and further, that way of diſcharge, rather than another: as, if there be a great appearance, that a diſeaſe will quickly have a criſis by ſweat; he will rather further it by covering the patient with warm cloaths and giving ſudorific medicines, than, by endeavouring to carry off the peccant matter by purging or vomiting, unſeaſonably hinder a diſcharge, that probably will be beneficial. And in this ſenſe men may ſay, if they pleaſe, that the phyſicians are miniſters or ſervants of nature; as ſeamen, when the Ship goes before a good wind, will not ſhift their ſails, nor alter the ſhip's motion, becauſe they need not. But to ſhew, that it is, as it were, by accident, that the phyſician does, in the forementioned caſe, obey nature, (to ſpeak in the language of the naturiſts I reaſon with,) I need but repreſent, that there are many other caſes, wherein the phyſician, if he be ſkilful, will be ſo far from taking nature for his miſtreſs, to direct him by her example, what ſhould be done; that a great part of his care and ſkill is employed to hinder her from doing what ſhe ſeems to deſign, and to bring to paſs other things very different from, if not contrary to, what ſhe endeavours.

THUS, though nature in dropſies importunately crave ſtore of drink, the phyſician thinks himſelf obliged to deny it; as he does what they greedily deſire, to his patients of the green-ſickneſs, or that diſtemper they call pica, though the abſurd and hurtful things, as very unripe fruit, lime, coals, and other incongruous things, be earneſtly longed for. Thus alſo the chirurgeon does often hinder nature from cloſing up the lips of a wound, as ſhe would unſkilfully do, before it be well and ſecurely healed at the bottom. So the phyſician does often, by purging or phlebotomy, carry off that matter, that nature would more dangerouſly throw into the lungs, and expel by frequent and violent coughs.

AND ſo, if a nerve or tendon be pricked, the chirurgeon is fain, with anodynes, and other convenient medicines, to prevent or appeaſe the unreaſonable tranſports of nature, when, being in a fury, by violent and threatning convulſions, ſhe not only much diſorders, but endangers, the patient. And ſo likewiſe, when in thoſe evacuations, that are peculiar to women, nature affects, in ſome individuals, to make them by undue and inconvenient places, as the nipples, the mouth, or the eyes, whereof we have divers inſtances, among the obſervations collected by *Schenkius*, or related by other good authors; the phyſician is careful, by bleeding the patient in the foot, and by uſing other means, to oblige nature to alter her purpoſe, and make the intended evacuations by the proper uterine veſſels: and though, according to the inſtitution of nature, as they ſpeak, there ought to be a monthly diſcharge of theſe ſuperfluities, and therefore, whilſt this is moderately made, the phyſician does rather further than ſuppreſs it; yet if, as it often happens in other patients, nature overlaſhes in making thoſe evacuations, to the great weakning or endanger-

Schenk. Obſer. l. iv. pag. m. 633. & ſeq.

ing the ſick perſon, the phyſician is careful, by contemperating medicines and other ways, to correct nature's exorbitancy, and check her profuſeneſs of ſo neceſſary a liquor, as the blood. Other inſtances, more conſiderable, than ſome of theſe hitherto mentioned, might be given to the ſame purpoſe; but I forbear to do it, becauſe, there being ſome, though perhaps very needleſs, controverſies about them, I could not make out their fitneſs to be here alledged, without more words, than I am now willing to employ about unneceſſary proofs, fearing it might be thought I have dwelt too long already upon the explication of one aphoriſm. I ſhall therefore only obſerve in ſhort, that I look upon a good phyſician, not ſo properly as a ſervant to nature, as one, that is a counſellor and friendly aſſiſtant, who, in his patient's body, furthers theſe motions and other things, that he judges conducive to the welfare and recovery of it; but as to thoſe, that he perceives likely to be hurtful, either by increaſing the diſeaſe, or otherwiſe endangering the patient, he thinks it is his part to oppoſe or hinder, though nature do manifeſtly enough ſeem to endeavour the exerciſing or carrying on thoſe hurtful motions.

ON this occaſion, I ſhall take notice of the practice of the more prudent among phyſicians themſelves, who being called to a patient ſubject to the flux of the hæmorrhoids, if they find the evacuation to be moderate, and likely either to benefit the patient on another account, (as in ſome caſes it is), or at leaſt to end well, they do, as ſome of them ſpeak, commit the whole buſineſs to nature; that is, to ſpeak intelligibly, they ſuffer it to take its courſe, being encouraged to do ſo, in ſome caſes, by the doctrine of *Hippocrates*, and in others by experience: but if the evacuation prove to be too laſting, or too copious, they then are careful to hinder nature from proceeding in it, and think themſelves obliged to employ both inward and outward means to put a ſtop to an evacuation, which may bring on a dropſy, or ſome other formidable diſeaſe. And if it be ſaid, that nature makes this profuſion of ſo neceſſary a liquor as blood, only becauſe ſhe is irritated by the acrimony of ſome humour mixed with it; I ſay, that this anſwer, which, for ſubſtance, is the very ſame, that naturiſts may be compelled to fly to on many occaſions, is in effect a confeſſion, that nature is no ſuch wiſe-being as they pretend; ſince ſhe is ſo often provoked to act, as it were, in a fury, and do thoſe things in the body, that would be very miſchievous to it, if the phyſician, more calm and wiſe than ſhe, did not hinder her. So that, notwithſtanding the reverence I pay the great *Hippocrates*, it is not without due caution and ſome limitations, that I admit that notable ſentence of his, where he thus ſpeaks; * *Invenit natura ipſa ſibi-ipſi aggreſſiones*: and after three or four lines, *Non edocta natura & nullo magiſtro uſa, ea quibus opus eſt facit*. Which, I fear, makes many phyſicians leſs courageous and careful than they ſhould, or perhaps would be, to employ their own ſkill on divers occaſions, that much require it.

Hippocrat. Lib. vi. Aphoriſm. xi.

I SHALL now add, that as, in ſome caſes, the phyſician relieves his patient in a negative way, by oppoſing nature in her unſeaſonable or diſorderly attempts; ſo, in other caſes, he may do it in a poſitive way, by employing medicines, that either ſtrengthen the parts, as well fluid as ſtable, or make ſenſible evacuations of matters neceſſary to be proſcribed by them; or (he may do it) by uſing remedies, that by their manifeſt qualities oppugn thoſe of the morbific matter or cauſes; as when by alcalies or abſorbing medicaments he mortifies preternatural acids, or diſables them to do miſchief. And, perhaps, one may venture to ſay, that, in ſome caſes, the phyſician may, in a poſitive way, contribute more to the cure even of an inward diſeaſe, than nature herſelf ſeems able to do: for if there be any ſuch medicine preparable by art, as *Helmont* affirms may be made of *Paracelſus's Ludus*, by the liquor alkaheſt; or, as *Cardan* relates, that an empirick had in his time, who, travelled up and down *Italy*, curing thoſe, wherever he came, that were tormented with the ſtone in the bladder; if, I ſay, there be any ſuch medicines, the phyſician may, by ſuch inſtruments, perform that, which, for aught appears, is not to be done by nature herſelf, ſince we never find, that ſhe diſſolves a confirmed ſtone in the bladder: nay, ſometimes the phyſician does, without the help of a medicine, controul and over-rule nature, to the great and ſudden advantage of the patient. For when a perſon, otherwiſe not very weak, happens by a fright, or ſome ſurpriſing ill news, to be ſo diſcompoſed, that the ſpirits haſtily and diſorderly thronging to ſome inward part, eſpecially the heart, hinder the regular and wonted motion of it, by which diſorder the circulation of the blood is hindered, or made very imperfect; in this caſe, I ſay, the patient is by nature's great care of the heart, (as is commonly ſuppoſed even by phyſicians,) caſt into a ſwoon, whence the phyſician ſometimes quickly frees him, by rubbing and pinching the limbs, the ears and the noſe, that the ſpirits may be ſpeedily brought to the external parts of the body; which muſt be done by a motion to the circumference, (as they call it,) quite oppoſite to that towards the centre or heart, which nature had given them before. But as to the theory of ſwoonings, I ſhall not now examine its truth, it being ſufficient to warrant my drawing from thence an argument *ad hominem*, that the theory is made uſe of by thoſe I reaſon with.

BY what has been diſcourſed one may perceive, that as there are ſome phænomena, that ſeem to favour the doctrine of the naturiſts about the cure of diſeaſes, ſo there are others, that appear more manifeſtly favourable to the hypotheſis we propoſe. And both theſe ſorts of phænomena being conſidered together, may well ſuggeſt a ſuſpicion, that the moſt wiſe and yet moſt free author of things having framed the firſt individuals of mankind ſo, as to be fit to laſt many years, and endowed thoſe Protoplaſts with the power of propagating their ſpecies; it thereupon comes to paſs, that in the ſubſequent hydraulico-pneumatical engines we call human bodies, when neither particular providence, nor the rational ſoul, nor over-ruling impediments interpoſe, things are generally performed according to mechanical laws and courſes; whether the effects and events of theſe prove to be conducive to the welfare of the engine itſelf, or elſe cheriſh and foment extraneous bodies or cauſes, whoſe preſervation and proſpering are hurtful to it. On which ſuppoſition it may be ſaid, that the happy things, referred to nature's prudent care of the recovery and welfare of ſick perſons, are uſually genuine conſequences of the mechaniſm of the world, and the patient's body; which effects luckily happen to be coincident with his recovery, rather than to have been purpoſely and wiſely produced in order to it; ſince I obſerve, that nature ſeems to be careful to produce, preſerve, and cheriſh things hurtful to the body, as well as things beneficial to it. For we ſee in the ſtone of the kidneys and bladder, that out of vegetable or animal ſubſtances of a ſlighter texture, ſuch as are the alimental juices, which, in ſucking children (who are obſerved to be frequently ſubject to the ſtone in the bladder) are afforded by ſo mild a liquor as milk; nature ſkilfully frames a hard body of ſo firm a texture, that it puzzles phyſicians and chymiſts to tell, how ſuch a coagulation can be made of ſuch ſubſtances: and I have found more than one calculus to reſiſt both ſpirit of ſalt, that readily diſſolves iron and ſteel, and that highly corroſive menſtruum, oil of vitriol itſelf. We ſee alſo, that divers times the ſeeds or ſeminal principles of worms, that lie concealed in unwholeſome fruits, and other ill qualified aliments, are preſerved and cheriſhed in the body ſo, as, in ſpight of the menſtruum's ferments, *&c.* they meet with there, they grow to be perfect worms, (of their reſpective kinds) that are often very troubleſome, and ſometimes very dangerous, to the body, that harbours them; producing, though perhaps not immediately, both more and more various diſtempers (eſpecially here in *England*) than every phyſician is aware of. This reflection may very well be applied to thoſe inſtances we meet with in good * authors, of frogs, and even toads, whoſe ſpawn, being taken in with corrupted water, hath been cheriſhed in the ſtomach, until the eggs being grown to be compleat animals, they produced horrid ſymptoms in the body, that had lodged and fed them. And if, according to the received opinion of phyſicians, ſtubborn quartans are produced by a melancholy humour ſeated in the ſpleen, it may be ſaid, that nature ſeems to buſy herſelf to convert ſome parts of the fluid chyle into ſo tenacious and hardly diſſipable a juice, that, in many patients, notwithſtanding the neighbourhood of the ſpleen and ſtomach, neither ſtrong emetics, nor purges, nor other uſual remedies, are able, in a long time, to diſlodge it, or reſolve it, or correct it. But that is yet more conducive to my preſent purpoſe, that is afforded me by the conſideration of the poiſon of a mad dog, which nature ſometimes ſeems induſtriouſly and ſolicitouſly to preſerve; ſince we have inſtances in approved authors, that a little foam conveyed into the blood by a ſlight hurt, (perhaps quickly healed up,) is, notwithſtanding the conſtant heat and perſpirable frame of the human body, and the diſſipable texture of the foam, ſo preſerved, and that ſometimes for many years, that, at the end of that long time, it breaks out, and diſplays its fatal efficacy with as much vigour and fury, as if it had but newly been received into the body.

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* *Hippoc.* Epidem. l. vi. § 5. text. 2. 4.

TO this agrees that, which is well known in *Italy*, about the biting of the tarantula; for, though the quantity of poiſon can ſcarce be viſible, ſince it is communicated by the tooth of ſo ſmall an animal as a ſpider, yet, in many patients, it is preſerved during a great part of their lives, and manifeſts its continuance in the body by annual paroxyſms. And I know a perſon of great quality, who complained to me, that, being in the Eaſt, the biting or ſtinging of a creature, whoſe offenſive arms were ſo ſmall, that the eye could very hardly diſcern the hurt, had ſo laſting an effect upon him, that, for about twelve years after, he was reminded of his miſchance, by a pain he felt in the hurt place, about the ſame time of the year, that the miſchief was firſt done him. And, in ſome hereditary diſeaſes, as the gout, falling-ſickneſs, and ſome kinds of madneſs, nature ſeems to act, as if ſhe did, with care as well as ſkill, tranſmit to the unhappy child ſuch morbific ſeeds or impreſſions of the parent's diſeaſe, that, in ſpight of all the various alterations the younger body paſſes through, during the courſe of many years, this conſtantly protected enemy is able to exert its power and malice, after forty, or perhaps fifty, years concealment. Such reflections as theſe, to which may be added, that the naturiſts make no ſcruple to ſtile that death, which men are brought to by diſeaſes, a natural death, make me backward to admit the famed ſentence of *Hippocrates* hitherto conſidered, *Morborum Naturæ Medici*, without limitations, eſpecially thoſe two, that are delivered in the fifth ſection; to which I refer you the rather, becauſe they may help you to diſcern, that divers phænomena, that favour not the received notion of a kind and prudent being, as nature is thought to be, are yet very conſiſtent with divine providence.

SECT. VIII.

I HAVE now gone through ſo many of the celebrated axioms concerning nature, that I hope I may reaſonably preſume, that the other ſentences of this kind, that my haſte makes me leave unmentioned, will be thought capable of being fairly explicated, and

* *Schenck.* Obſerv. lib. iii. pag. mihi 337. & ſeq.

and with congruity to our hypotheſis, by the help of the grounds already laid, ſince, with light variations, they may be eaſily enough improved, and applied to thoſe other particulars, to which they are the moſt analogous.

But this intimation ought not to hinder me to make a reflection, that not only is pertinent to this place, but which I deſire may have retroſpect upon a great part of the whole precedent diſcourſe. And it is this, that though we could not intelligibly explicate all the particular axioms about nature, and the phænomena of inanimate bodies, that are thought, but not by me granted, to favour them by mechanical principles; it would not follow, that we muſt therefore yield up the whole cauſe to the naturiſts: for we have already ſhewn, and may do ſo yet further e'er long, that the ſuppoſition of ſuch a being, as they call nature, is far from enabling her partizans to give intelligible accounts of theſe and other phænomena of the univerſe. And though our doctrine ſhould be granted to be, as well as that generally received about nature, inſufficient to give good accounts of things corporeal; yet I ſhall have this advantage in this caſe, that a leſs degree of probability may ſerve, in arguments employed but to juſtify a doubt, than is required in thoſe, that are to demonſtrate an aſſertion.

It is true, that the naturiſts tell us, that the nature they aſſert is the principle of all motions and operations in bodies; which infers, that in explicating them, we muſt have recourſe to her. But before we acquieſce in, or confidently employ, this principle, it were very fit we knew what it is. This queſtion I have diſcourſed of in the fifth ſection; but having there intimated a reference to another place, the importance, as well as difficulty of the ſubject, invites me to reſume, in this place, the conſideration of it; and both vary and add to what I formerly noted, that I may as well inculcate as clear my thoughts about it. I demand then of thoſe, that aſſert ſuch a nature, as is vulgarly deſcribed, whether it be a ſubſtance or an accident? If it be the latter, it ſhould be declared, what kind of accident it is; how a ſolitary accident can have right to all thoſe attributes, and can produce thoſe numerous, manifold, and wonderful effects, that they aſcribe to nature; and why a complex of ſuch accidents, as are the mechanical affections of matter, (as figure, bulk, motion, *&c.*) may not altogether as probably, as that accident they call nature, be conceived to have been inſtituted by the perfectly wiſe Author of the univerſe, to produce thoſe changes among bodies, which are (at leaſt for the moſt part) intelligibly referrible to them? And if things be not brought to paſs by their intervention, it were very fit, as well as deſirable, that we ſhould be informed, by what other particular and intelligible means nature can effect them better, than they may be by that complex.

But if it be ſaid, as by moſt it is, that the principle, called nature, is a ſubſtance, I ſhall next demand, whether it be a corporeal, or an immaterial one? If it be ſaid to be an immaterial ſubſtance, I ſhall further aſk, whether it be a created one, or not? If it be not, then we have God under another name, and our diſpute is at end, by the removal of its object or ſubject, which is ſaid by the ſchools to be God's vicegerent, not God himſelf. But if nature be affirmed (as ſhe is, at leaſt by all Chriſtian philoſophers) to be a created being, I then demand, whether or no ſhe be endowed with underſtanding, ſo as to know what ſhe does, and for what ends, and by what laws ſhe ought to act? If the anſwer be negative, the ſuppoſition of nature will be of very little uſe to afford an intelligible account of things; an unintelligent nature being liable to the objections, that will a little below be met with againſt the uſefulneſs of nature, in caſe ſhe be ſuppoſed a corporeal being. And though it ſhould be ſaid, that nature is endowed with underſtanding, and performs ſuch functions as divers of the antients aſcribe to the ſoul of the world; beſides that this hypotheſis is near of kin to heatheniſm, I do not think, that they, who ſhall with many Grecian, and other philoſophers, who preceeded Chriſtianiſm, ſuppoſe a kind of ſoul of the univerſe, will find this principle ſufficient to explicate the phænomena of it. : for if we may compare the macrocoſm and microcoſm in this, as well as many are wont to do in other things, we may conceive, that, though nature be admitted to be endowed with reaſon, yet a multitude of phænomena may be mechanically produced, without her immediate intervention; as we ſee, that in a man, though the rational ſoul has ſo narrow a province to take care of, as the human body, and is ſuppoſed to be intimately united to all the parts of it; yet abundance of things are done in the body by the mechaniſm of it, without being produced by that ſoul. Of this we may alledge, as an inſtance, that, in ſleep, the circulation of the blood, the regular beating of the heart, digeſtion, nutrition, reſpiration, *&c.* are performed without the immediate agency, or ſo much as the actual knowledge, of the mind: and, when a man is awake, many things are done in his body, not only without the direction, but againſt the bent of his mind; as often happens in cramps and other convulſions, coughing, yawnings, *&c.* Nay, though ſome brutes, as particularly apes, have the ſtructure of many parts of their bodies very like that of the analogous ones of human bodies; yet that admirable work of the formation and organization of the fœtus, or little animal, in the womb, is granted by philoſophers to be made by the ſoul of the brute (that is therefore ſaid to be the architect of his own manſion,) which yet is neither an incorporeal, nor a rational ſubſtance. And, even in a human fœtus, if we will admit the general opinion of philoſophers, phyſicians, divines and lawyers, I may be allowed to obſerve, that the human body, as exquiſite an engine as it is juſtly eſteemed, is formed without the intervention of the rational ſoul, which is not infuſed into the body, till this hath obtained an organization, that fits it to receive ſuch a gueſt; which is commonly reputed to happen about the end of the ſixth week, or before that of the ſeventh. And this conſideration leads me a little further, and prompts me to aſk, how much, by the ſuppoſition or knowledge of the mind, (at the newly mentioned time) we are enabled to explicate the manner, how the forementioned functions of an embryo are performed, when at the end of ſix or ſeven weeks the rational ſoul ſupervenes and comes to be united to this living engine?

And if it be urged, that nature being the principle of motion in bodies, their various motions, at leaſt, which amount to a conſiderable part of their phænomena, muſt be explained by having recourſe to her; I anſwer, that it is very difficult to conceive, how a created ſubſtance, that is immaterial, can, by a phyſical power or action move a body; the agent having no impenetrable part, wherewith to impel the corporeal *mobile*. I know, that God, who is an immaterial ſpirit, ought to be acknowledged the primary cauſe of motion in matter, becauſe (as we may juſtly with *Monſieur Des Cartes* infer) motion not belonging to corporeal ſubſtance, as ſuch, this muſt owe that to an incorporeal one. But then, I conſider, that there is that infinite diſtance between the incomprehenſible Creator, and the leaſt imperfect order of his creatures, that we ought to be very cautious, how we make parallels between him and them, and draw inferences from his power and manner of acting to theirs; ſince he, for inſtance, can immediately act upon human ſouls, as having created them, but they are not able ſo to act upon another. And I think it the more difficult to conceive and admit, that, if nature be an incorporeal ſubſtance, ſhe ſhould be the greater mover of the mundane matter, becauſe we ſee, that, in a human body, the rational ſoul, (which the ſchool-philoſophers aſſert to be an immaterial ſpirit) though vitally united to it, can only determine the motion of ſome of the parts, but not give motion to any, or ſo much as regulate it in moſt. And if nature be ſaid to move bodies in another than a phyſical way, I doubt, whether the ſuppoſition of ſuch a principle will be of much uſe to phyſiologers in explicating phænomena; ſince I ſhall ſcarce think him an inquiſitive or a judicious doctor, who ſhould imagine, that he explains, that it gives an intelligible and particular account of the aſtoniſhing ſymptoms of thoſe ſtrange diſeaſes, that divers very learned and ſober phyſicians impute to witchcraft, when he ſays, that thoſe ſtrange diſtortions and convulſive motions, for inſtance, and other prodigious effects, were produced by a wicked immaterial ſpirit, called a devil. But having to this purpoſe ſaid more in another paper, which you may command the ſight of, I ſhall not trouble you with it here.

The paſt diſcourſe oppoſes their opinion, who aſſert nature to be an immaterial creature; but becauſe it is thought, that a greater number of philoſophers, at leaſt among the moderns, take her to be corporeal, I ſhall now addreſs my diſcourſe to their hypotheſis. And though I might object, that, if nature be a body, it may be demanded, how ſhe can produce, in men, rational ſouls, that are immaterial beings, and not capable to be produced by any ſubtiliation or other change of matter whatſoever? yet, waving this objection, I ſhall firſt demand, whether thoſe, I reaſon with, believe nature, though corporeal, to act knowingly, *i. e.* with conſciouſneſs of what ſhe does, and for pre-deſigned ends; or elſe to be blindly and neceſſarily moved and directed by a ſuperior agent, endowed with (what ſhe wants) an excellent underſtanding; and then I ſhall repreſent a few things, appliable to ſome one or other of the two anſwers, that may be made, and ſome to both.

And firſt, the Carteſians would aſk, how, if nature be a corporeal ſubſtance, we can conceive her capable of thinking? and, which is more, of being a moſt wiſe and provident director of all the motions, that are made in the corporeal world?

Secondly, a philoſophizer may juſtly aſk, how a corporeal being can ſo pervade, and, as it were, com-penetrate the univerſe, as to be intimately preſent with all its minute parts, whereof yet it is ſaid to be the principle of motion?

Thirdly, he may alſo demand, whence nature, being a material ſubſtance, comes itſelf to have motion, whereof it is ſaid to be the principle? ſince motion does not belong to matter in itſelf, and a body is as truly a body, when it reſts, as when it moves. And if it be anſwered, that the firſt cauſe, that is, God, did at firſt put it into motion; I reply, that the ſame cauſe may, at leaſt as probably, be ſuppoſed to have put the unqueſtioned mundane matter into motion, without the intervention of another corporeal being, in whoſe conception, (*i. e.* as it is matter) motion is not involved.

Fourthly, it may likewiſely be aſked, how the laws of motion come to be obſerved or maintained by a corporeal being? which, as merely ſuch, is either uncapable of underſtanding them, or of acting with reſpect to them, or at leaſt is not neceſſarily endowed with any knowledge of them, or power to conform to them, and to make all the parts of the unqueſtioned mundane matter to do ſo too.

Fifthly, and I do not ſee, how the taking in ſuch an unintelligent and undeſigning principle will free our underſtandings from great difficulties, when we come to explicate the phænomena of bodies: for, as is elſewhere noted, if nature be a bodily creature, and acts neceſſarily, and (if I may ſo ſpeak) fatally, I ſee no cauſe to look upon it but as a kind of engine; and the difficulty may be as great to conceive, how all the ſeveral parts of this ſuppoſed engine, called nature, are themſelves framed and moved by the great Author of things, and how they act upon one another, as well as upon the undoubted mundane bodies; as it is to conceive, how, in the world itſelf, which is manifeſtly an admirably contrived automaton, the phænomena may, by the ſame Author, (who was able to endow bodies themſelves with active power, as well as he could, on other ſcores, make them cauſes) be produced by virtue, and, in conſequence of the primitive conſtruction and motions, that he gave it (and ſtill maintains in it) without the intervention of ſuch a thing, as they call nature: for this, as well as the world, being a corporeal creature, we cannot conceive, that either of them act otherwiſe, than mechanically. And it ſeems very ſuitable to the Divine Wiſdom, that is ſo excellently diſplayed in the fabrick and conduct of the univerſe, to employ in the world, already framed and compleated, the feweſt and moſt ſimple means, by which the phænomena, deſigned to be exhibited in the world, could be produced. Nor need we be much moved by hearing ſome naturiſts ſay, that nature, though not an incorporeal being, is of an order ſuperior to mere matter; as divers of the ſchoolmen teach the things, they call material forms to be: for who can clearly conceive an order or kind of beings, that ſhall be real ſubſtances, and yet neither corporeal nor immaterial? Nor do I ſee, how the ſuppoſition of this unintelligible, or at leaſt unintelligent being, though we ſhould grant it to have a kind of life or ſoul, will much aſſiſt us to explicate the phænomena; as if a man be acquainted with the conſtruction of mills, he may as well conceive, how corn is ground by a mill driven by the wind or by a ſtream of water, which are brute and ſenſeleſs beings, as he can by knowing, that it is kept at work by a horſe, who, though an animated being, acts in our caſe but as a part of an engine, that is determined to go round, and who does neither intend to grind the corn, nor know, that he grinds it.

AND in this place (though perhaps not the very fitteſt) I may queſtion, with what congruity to their maſter's doctrine, the ſchool-philoſophers teach, that nature is the principle of motion in all the bodies, they call natural. For, not to urge, that thoſe great maſſes of ſublunary matter, to which they give the name of elements, and the mixed bodies, that conſiſt of them, are, by divers learned men, ſaid to be moved to or from the centre of the earth, by diſtinct internal principles, which they call gravity in the earth and water, and levity in the fire and air; and that there is aſcribed alſo to every compounded body, that quality of the two, which belongs to the element, that predominates in it: not to urge this, I ſay, conſider, that the cœleſtial part of the world does ſo far exceed the ſub-cœleſtial in vaſtneſs, that there is ſcarce any compariſon between them; and yet the generality of the Peripateticks, after *Ariſtotle*, tells us, that the cœleſtial globes of light, and the vaſt orbs they ſuppoſe them to be fixed in, are moved from weſt to eaſt by the intelligences, that is, rational and ſeparate beings, without whoſe conduct, they preſume, that the motions of the heavens could not be ſo regular and durable, as we ſee they are: ſo that, in that part of the univerſe, which is incomparably vaſter than the ſublunary is, intelligences being the cauſes of motion, there is no recourſe to be had to nature, as the true and internal principle of it.

AND here it may not, perhaps, be improper to declare ſomewhat more fully a point already touched upon; namely, that, if to know what is the general efficient cauſe of motion, can much contribute to the explication of particular phænomena, the hypotheſis of thoſe naturiſts, I now reaſon with, will have no conſiderable advantage, if any at all, of ours; which derives them from the primitive impulſe given by God to matter, and from the mechanical affections of the greater and leſſer portions of it. For it is all one to him, that would declare by what particular motion, as ſwift, ſlow, uniform, accelerated, direct, circular, parabolical, &c. this or that phænomenon is produced, to know, whether the motions of the parts of matter were originally impreſſed on them by nature, or immediately by God; unleſs it be, that he, being of infinitely perfect knowledge, may be, more probably than a creature, ſuppoſed to have at firſt produced in matter motions beſt accommodated to the phænomena, that were to be exhibited to the world. Nor do I ſee ſufficient cauſe to grant, that nature herſelf (whatever ſhe be) produces any motion *de novo*, but only, that ſhe transfers and regulates that, which was communicated to matter at the beginning of things; (as we formerly noted, that in the human body, the rational ſoul or mind has no power to make new motions, but only to direct thoſe of the ſpirits and of the groſſer organs and inſtruments of voluntary motion.) For, beſides that many of the modern naturaliſts approve of the Carteſian opinion, that the ſame quantity of motion is always preſerved in the whole maſs of the mundane matter, that was communicated to it at firſt, though it be perpetually transferring it from one part to another; beſides this, I ſay, I conſider, that, if nature produces in theſe and thoſe bodies motion, that were never before in beings; (unleſs much motion be annihilated, which is a thing as yet unproved) the quantity of motion in the univerſe muſt have for ſome thouſands of years perpetually increaſed, and muſt continue to do ſo; which is a conceſſion, that would much diſorder the whole theory of local motion, and much perplex philoſophers, inſtead of aſſiſting them, in explicating the phænomena of bodies.

And as for the effects of local motion in the parts of the univerſal matter, which effects make a great part of the phænomena of the world; after what I have formerly declared, you will not wonder to hear me confeſs, that, to me, the ſuppoſition of nature, whether men will have her an immaterial or corporeal ſubſtance, and either without knowledge or elſe endowed with underſtanding, doth not ſeem abſolutely neceſſary, nor perhaps very uſeful, to make us comprehend, how they are produced. The bodies of animals are divers of them little leſs curiouſly framed than men's, and moſt of them more exquiſitely, than, for aught we know, the great inanimate maſs of the corporeal world is; and yet, in the judgment of no mean naturaliſts, ſome of the mechanical philoſophers, that deny cogitation, and even ſenſe properly ſo called, to beaſts, do, at leaſt as intelligibly and plauſibly, as thoſe, that aſcribe to them ſouls endowed with ſuch faculties, as make them ſcarce more than gradually different from human ones, explicate the phænomena, that are obſerved in them. And I know not, whether I may on this occaſion add, that the Peripateticks themſelves, eſpecially the moderns, teach ſome things, whence one may argue, that the neceſſity of recurring to nature does not reach to ſo many things by far, as is by them ſuppoſed. For the efformation (or framing) of the bodies of plants and animals, which are, by great odds, the fineſt pieces of workmanſhip to be met with among bodies, is aſcribed not immediately to nature, but to the ſoul itſelf, which they will have to be the author of the organization of the body, and therefore call it the architect of its own manſion; which, they ſay, that it frames by an innate power and ſkill, that ſome call plaſtick, and to which others give other names. And unto the ſame ſoul, operating by her ſeveral functions, they attribute the concoction of aliments, the expulſion of excrements, the production of milk, ſemen, *&c.* the appetitive, loco-motive, and I know not how many other faculties, aſcribed to living bodies. And, even in many inanimate ones, the nobleſt properties and operations are, by the ſame ſchool-philoſophers, attributed to what they call their ſubſtantial forms; ſince from theſe they derive the wonderful properties of the load-ſtone, the attractive faculty of amber and other electricks, and the medical virtues of gems and other mineral bodies, whether conſiſtent or fluid.

But not to inſiſt on this argument, becauſe it is but *ad hominem*, (as they ſpeak) if we conſider the thing itſelf, by a free examen of the pretended explanations, that the vulgar philoſophers are wont, by recurring to nature, to give of the phænomena of the univerſe; we ſhall not eaſily look on thoſe accounts, as meriting the name of explications. For to explicate a phænomenon, it is not enough to aſcribe it to one general efficient, but we muſt intelligibly ſhew the particular manner, how that general cauſe produces the propoſed effect. He muſt be a very dull inquirer, who, demanding an account of the phænomena of a watch, ſhall reſt ſatisfied with being told, that it is an engine made by a watch-maker; though nothing be thereby declared of the ſtructure and co-aptation of the ſpring, wheels, balance, and other parts of the engine, and the manner, how they act on one another, ſo as to co-operate to make the needle point out the true hour of the day. And (to improve to my preſent purpoſe an example formerly touched upon) as he, that knows the ſtructure and other mechanical affections of a watch, will be able by them to explicate the phænomena of it, without ſuppoſing, that it has a ſoul or life to be the internal principle of its motions or operations; ſo he, that does not underſtand the mechaniſm of a watch, will never be enabled to give a rational account of the operations of it, by ſuppoſing, as thoſe of *China* did, when the Jeſuits firſt brought watches thither, that a watch is an European animal, or living body, and endowed with a ſoul. This compariſon ſeems not ill to befit the occaſion of propounding it; but to ſecond it by another, that is more purely phyſical, when a perſon, unacquainted with the mathematicks, admires to ſee, that the ſun riſes and ſets in winter in ſome parts of the horizon, and in ſummer in others, diſtant enough from them; that the day, in the former ſeaſon, is, by odds ſhorter, than in the latter, and ſometimes (as ſome days before the middle of *March* and of *September*) the days are equal to the night; that the moon is ſometimes ſeen in conjunction with the ſun, and ſometimes in oppoſition to him; and, between thoſe two ſtates, is every day variouſly illuminated; and that ſometimes one of thoſe planets, and ſometimes another ſuffers an eclipſe; this perſon, I ſay, will be much aſſiſted to underſtand, how theſe things are brought to paſs, if he be taught the clear mathematical elements of aſtronomy: but if he be of a temper to reject theſe explications, as too defective, it is not like, that it will ſatisfy him, to tell him after *Ariſtotle* and the ſchoolmen, that the orbs of the ſun and moon, and other cœleſtial ſpheres, are moved by angels or intelligences; ſince to refer him to ſuch general and undetermined cauſes, will little, or not at all, aſſiſt him to underſtand, how the recited phænomena are produced.

If it be here objected, that theſe examples are drawn from factitious, not from merely phyſical bodies, I ſhall return this brief anſwer, and deſire, that it be applied not only to the two freſhly mentioned examples, but to all of the like kind, that may be met with in this whole treatiſe, (near the beginning of which, had I remembered it, ſomething to to the ſame purpoſe ſhould have had place.) I ſay then in ſhort, that divers of the inſtances we are ſpeaking of are intended but for illuſtrations; and that others may be uſeful inſtances, if they ſhould be no more than analogous ones: ſince examples, drawn from artificial bodies and things, may have both the advantage of being more clearly conceived by ordinary underſtandings, and that of being leſs obnoxious to be queſtioned in that particular, in which the compariſon or correſpondence conſiſts. And I the leſs ſcruple to employ ſuch examples, becauſe *Ariſtotle* himſelf, and ſome of his more learned followers, make uſe of divers compariſons, drawn from the figures and other accidents of artificial things, to give an account of phyſical ſubjects, and even of the generation, corruption, and forms of natural bodies.

THIS advertiſement premiſed, I purſue the diſcourſe it interrupted, by adding, that thus we ſee that confirmed, which was formerly obſerved; namely, that though mechanical principles could not be ſatisfactorily employed for explaining the phænomena of our world; we muſt not therefore neceſſarily recur to, and acquieſce in that principle, that men call nature, ſince neither will that intelligibly explain them; but in that caſe, we ſhould ingenuouſly confeſs, that we are yet at a loſs, how they are performed; and that this ignorance proceeds, rather from the natural imperfection of our underſtandings, than from our not preferring nature (in the vulgar notion of it) to the mechanical principles, in the explication of the phænomena of the univerſe. For whereas *Monſieur Des Cartes*, and other acute men, confidently teach, that there are ſcarce any of theſe phænomena, that have been truly and intelligibly deduced from the principles peculiar to the Ariſtotelians and ſchool-philoſophers; it will ſcarce be denied by any, that is acquainted with phyſico-mathematical diſciplines, ſuch as opticks, aſtronomy, hydroſtaticks, and mechanicks, more ſtrictly ſo called, but that very many effects (whereof ſome have been handled in this preſent tract) are clearly explicable by mechanical principles; which, for that reaſon, *Ariſtotle* himſelf often employs in his *Quæſtiones Mechanicæ*, and elſewhere: ſo that, if becauſe the Corpuſcularian principles cannot be ſatisfactorily made uſe of to account for all, that happens among things corporeal, we muſt refuſe to acquieſce in them; it is but juſt, that, ſince a recourſe to what is called nature is yet more dark and inſufficient, at leaſt, we muſt reject as well the latter as the former hypotheſis, and endeavour to find ſome other preferable to both.

AND now, if it be demanded, what benefit may redound to a reader from the explications given in the foregoing ſeventh ſection? and in general, from the troubleſome, as well as free inquiry, whereof they make a conſiderable part? I ſhall anſwer, that I am not quite out of hope, that the things hitherto diſcourſed may do ſome ſervices both to natural philoſophy and to religion.

AND as to the firſt of theſe; this tract may be of uſe to the cultivators of that ſcience, by diſſuading them from employing often, and without great need, in their philoſophical diſcourſes and writings, a term, (I mean nature) which, by reaſon of its great ambiguity, and the little or no care, which thoſe, that uſe it, are wont to take, to diſtinguiſh its different acceptions, occaſions both a great deal of darkneſs and confuſedneſs in what men ſay and write about things corporeal; and a multitude of controverſies, wherein really men do but wrangle about words, whilſt they think they diſpute of things; and perhaps would not differ at all, if they had the ſkill or luck to expreſs themſelves clearly. Beſides which ſervice, the paſt diſcourſe may do this other, to wean many from the fond conceit they cheriſh, that they underſtand or explicate a corporeal ſubject or a phænomenon, when they aſcribe it to nature; for to do that, one needs not be a philoſopher, ſince a country ſwain may eaſily do the ſame thing.

ON this occaſion, I muſt not forbear to take notice, that the unſkilful uſe of terms of far leſs extent and importance, and alſo leſs ambiguous, than the word nature is, has been, and ſtill is, no ſmall impediment to the progreſs of ſound philoſophy. For not only the greateſt part both of phyſicians (though otherwiſe learned men) and of chymiſts; but the generality of phyſiologers too, have thought, that they have done their part, though not on all occaſions, yet on very many, when they have referred an effect or a phænomenon to ſome ſuch things as thoſe, that are preſumed to be real qualities; or are by ſome ſtiled natural powers, or are by others, by a more comprehenſive and more uſual name, (which therefore here chiefly employ) called faculties; for each of which they are wont to form a name, fit for their purpoſe; though they do not intelligibly declare, what this faculty is, and in what manner the operations they aſcribe to it, are performed by it. Thus the attractive faculty aſcribed to a man, that is enabled by nature's (preſumed) abhorrence of a vacuum, to ſuck up drink through a ſtraw or pipe, has been for many ages acquieſced in, as the true cauſe of the aſcenſion of that liquor in ſuction; of which nevertheleſs the modern philoſophers, that have ſlighted explications derived merely from faculties, have aſſigned (as has been already declared) intelligibly, and even mechanical cauſes. The power, that a load-ſtone has with one pole to attract (as they ſpeak) the northern point of the mariner's needle, and with the other to drive it away, is looked upon as one of the nobleſt and moſt proper faculties of that admirable ſtone. And yet I elſewhere ſhew, how in a very ſmall, indeed, but true and natural magnet, I have, by a bare, and ſometimes inviſible change of texture, given that extreme of the magnet, that before drew the ſouthern point of the needle, the power to draw the northern, and to the oppoſite extreme, the power to drive it away; ſo much does even this wonderful attractive faculty, as it is called, depend upon the mechanical ſtructure of the mineral, and its relation to other bodies, among which it is placed, eſpecially the globe of the earth, and its magnetical effluvia.

But becauſe in another paper I purpoſely diſcourſe of what naturiſts call faculties, I ſhall here content myſelf to note in general, that the term faculty may, indeed, be allowed of, if it be applied as a compendious form of ſpeech, but not as denoting a real and diſtinct agent; ſince in reality the power or faculty of a thing is (at leaſt) oftentimes but the matter of it, made operative by ſome of its mechanical modifications; [I ſay ſome, becauſe the complex of all makes up its particular nature.] And with how little ſcruple ſoever men commonly ſpeak of faculties, as ſuppoſing them to be diſtinct and active principles; yet this condition does not neceſſarily belong to them: for ſometimes, if not frequently, the effect of what is reputed a natural power or faculty, is produced by the texture, figure, and, in a word, mechanical diſpoſition of the agent, whereby it determines the action of a remoter agent to the produced effect. Thus in a clock, to make the balance vibrate, to point at the hour, to make, at ſet times, the hammer ſtrike upon the bell, are but different effects of the weight or ſpring, that ſets and keeps the engine in motion. And ſo a key may either acquire or loſe its power of opening a door, (which, perhaps, ſome ſchoolmen would call its aperitive faculty) by a change, not made in itſelf, but in the locks it is applied to, or in the motion of the hand, that manages it. And leſt it ſhould be objected, that theſe inſtances are taken wholly from artificial bodies, I ſhall add, that when a clear piece of native chryſtal has obtained, as it often does, a good priſmatical ſhape, and is, in a due poſition, expoſed to the ſun-beams, its figuration, by enabling it to refract and reflect thoſe beams after a certain manner, gives it a colorific faculty, whereby it is enabled to exhibit that wonderful and pleaſing variety of colours, that emulate, if not ſurpaſs thoſe of the Rain-bow. And ſo in a concave metalline looking-glaſs, though there ſeem to be many diſtinct faculties, ſuch as that of reflecting, inverting, magnifying divers objects, and melting, burning, *&c.* ſeveral bodies; yet all theſe powers are but the genuine conſequences of the figure, capacity and ſmoothneſs, which are mechanical affections of the matter of the ſpeculum.. And indeed, if I judge aright, (though what I am going to ſay will ſeem a paradox,) *yet many qualities of very many bodies are but laſting diſpoſitions to be thus or thus wrought upon by the action of external agents*, and alſo (perchance) to modify that action; as we ſee, that the power of making an eccho, that is obſerved in divers hollow places, is nothing but the mechanical diſpoſition their figure and reſiſtance gives them to reflect a ſound. And, to reſume the lately mentioned inſtance of a key; we may add, that, by bare poſition, either end of it, eſpecially if the key be long, may be made to acquire or loſe a tranſient magnetic faculty from the effluvia of that great magnet, the earth; and that alſo the ſame key may, in a few moments, acquire a durable magnetiſm, by a mechanical change received from the loadſtone, as is known to thoſe, that are any thing verſed in the philoſophy of that wonderful mineral.

And to me it ſeems likely, that one main reaſon, why learned men have aſcribed ſuch inherent and active powers, as they call faculties, to ſo many bodies, is, becauſe that not being converſant enough with natural and artificial things, they did not duly perpend, how great a difference there may be between a body conſidered abſolutely, or by itſelf, and the ſame body conſidered in ſuch circumſtances, as it may be found in. For in ſome caſes a phyſical body may have ſtrange things juſtly aſcribed to it, though not as it is ſuch a body conſidered ſimply, or unaſſociated with other bodies; but as it is placed among congruous ones, and makes the principal or moſt operative part of a compounded body, or of the complex of bodies it is joined with, and which are of ſuch determinate ſtructures, as are convenient for the phænomena to be exhibited. This may be analogically ſeen in what happens to a ſpring; for if, being bent, it is held in one's hand, or crouded into a box, it is but a ſimple thing, that does only, by its expanſive endeavour, ſtrive to remove the bodies, that keep it compreſſed: but in a curious watch, it may, by virtue of the ſtructure of that engine, become the principle of I know not how many differing, and perhaps contrary, motions among the parts of it, and of many notable phænomena and effects exhibited or produced thereby. This reflection may perhaps be improved, if I here add, that, in many bodies, a fluid ſubſtance, determined to convenient motions, may be equivalent to an internal ſpring, eſpecially if it be aſſiſted by friendly external agents. This may be illuſtrated by conſidering, that if one, that plays ſkilfully on a flute, blow out of his mouth into the open air, he will but turn it into a vapid aerial ſtream; but if this wind duly paſs into the inſtrument, and be modified there by the muſician's fingers and ſkill, the ſimple ſtream of air may be formed into very various and melodious tunes. Thus gunpowder artificially tempered, though, if it be fired in the open air, it will give only a rude and ſudden flaſh, that preſently vaniſhes; yet, if it be ſkilfully diſpoſed of in rockets and other well-contrived inſtruments, and then kindled, it will exhibit a great and pleaſing variety of ſhining bodies and phænomena, that are juſtly admired in the beſt ſort of artificial fire-works. A phyſical inſtance alſo, in favour of our analogical or vicarious ſprings (if I may ſo call them,) is afforded me by the bulbs of onions, and the roots of aloes, commonly called ſempervive, and ſome other vegetables, which in the ſpring being expoſed to the air, the juices and ſpirits contained in them, will be ſo agitated by the warmth of that ſeaſon, and ſo modified by the particular ſtructure of the more firm parts, that, though neither earth nor rain co-operate, they will ſhoot forth green ſtalks or leaves for many weeks together, as if they were planted in a good ſoil; (though the matter of theſe green productions be furniſhed by the radical parts themſelves, as may be argued both from the manifeſt diminution of the bulb in bigneſs, and the great and gradual decrement in weight, that I obſerved in making experiments of this kind. And ſo alſo the air, which is an external fluid, concurring with the juices and ſpirits of divers inſects and other cold animals, may both be put into motion, and have that motion ſo determined by their organization, as to recover in the ſpring or ſummer, as it were, a new life, after they have lain moveleſs and like dead things, all the winter; as we ſee in flies, that, in a hot air, quickly recover motion and ſenſe, after having loſt both, for perhaps many months. And the like change may be far more ſuddenly obſerved in them, in the warmer ſeaſons of the air, when the air is drawn from them by the pneumatic pump, and afterwards permitted to enliven them again. And to give another inſtance, that may poſſibly pleaſe better, (becauſe, as it is purely phyſical, ſo it is ſimple and very conſpicuous,) though that, which the ſunbeams are wont primarily to produce be but light, and perhaps, heat; yet falling in a due manner upon a rorid cloud, they form there the figure of a vaſt bow, and, being variouſly reflected and, refracted, adorn it with the ſeveral colours men admire in the rainbow.

BUT I muſt not farther proſecute an obſervation, that I mentioned but occaſionally, as an inſtance, whereby to ſhew, that the advancement of ſolid philoſophy may be much hindered by men's cuſtom of aſſigning, as true cauſes of phyſical effects, imaginary things or perhaps arbitrary names; among which none ſeems to have had a more malevolent influence upon phyſiology, than the term nature, none having been ſo frequently and confidently uſed, or employed to ſo many differing purpoſes. And therefore, though I would not totally forbid the uſe of the word nature, nor of expreſſions of kin to it, in popular diſcourſes, or even in ſome philoſophical ones, where accurateneſs is not required, or ambiguity is prevented by the context; nor (to diſpatch) where it may be employed as a compendious form of ſpeech, without danger to truth, or prejudice to ſound philoſophy, (in which caſes I myſelf forbear not the uſe of it;) yet, I hope, our free inquiry may (ſomewhat at leaſt,) conduce to the more ſkilful indagation and happy diſcovery of phyſical truths, if it can perſwade men to make uſe leſs frequently, and with more circumſpection, of ſo ambiguous, and ſo often abuſed, a term as nature; and ceaſe to preſume, that a man has well performed the part of a true phyſiologer, till he have circumſtantially or particularly deduced the phænomenon he conſiders, by intelligible ways, from intelligible principles: which he will be conſtantly put in mind of doing, or diſcover, that he hath not done it, if, by forbearing general and ambiguous terms and words, he endeavours to explain things by expreſſions, that are clear to all attentive readers furniſhed with an ordinary meaſure of underſtanding and reaſon. And this perſpicuous way of philoſophizing ſhould be not a little recommended to ingenious men, by the valuable diſcoveries, which thoſe, that have employed it, in their reſearches and explications of difficult things, have in this inquiſitive age happily made, not only about the various phænomena commonly referred to the fuga vacui, but in the hydroſtatics, optics, anatomy, botanics, and divers other parts of real learning, that I cannot now ſtay to enumerate. And thus much it may poſſibly be ſufficient to have ſaid about the ſervice our doctrine may do natural philoſophy.

AS for religion, if what I have formerly ſaid in favour of it be duly conſidered and applied, the paſt diſcourſe will not appear unfriendly, nor perhaps uſeleſs, to it. And therefore, if I do here abridge what I have there ſaid, and add to it ſome conſiderations, that were fit to be reſerved for this place; I hope the doctrine we have propoſed may appear fit to do it a threefold ſervice.

I. AND in the firſt place, our doctrine may keep many, that were wont, or are inclined, to have an exceſſive veneration for what they call nature, from running, or being ſeduced, into thoſe extravagant and ſacrilegious errors, that have been upon plauſible pretences embraced not only by many of the old heathen philoſophers, but by divers modern profeſſors of Chriſtianity, who have of late revived, under new names and dreſſes, the impious errors of the Gentiles. This I venture to ſay, becauſe many of the heathen writers, as hath been ſhewn in the fourth ſection, acknowledged indeed a God (as theſe alſo own they do,) but meant ſuch a God, as they often too little diſcriminated from matter, and even from the (a) world, and as is very differing from the true one adored by Chriſtians and Jews: for ours is a God, firſt, infinitely perfect; and then ſecondly, by conſequence, both incorporeal and too excellent to be ſo united to matter, as to animate it like the heathen's mundane ſoul, nor to become to any body a ſoul properly ſo called; and thirdly, uncapable of being divided, and having either human ſouls or other beings, as it were, torn or carved out, or otherwiſe ſeparated from him, ſo as to be truly parts or portions of his own ſubſtance.

(a) Thus the Stoicks, in *Laertius*, deſcribe the world thus, *Mundus eſt, qui conſtat ex cœlo & terra, atque ex illorum naturis; ſive, qui conſtat ex diis & hominibus, iiſque rebus, quæ horum gratia conditæ ſunt.* And of *Chryſippus*, one of the patriarchs of that ſect, the ſame † hiſtorian in the ſame book ſays, *Puriſſimum dixit ac liquidiſſimum æthera, quem etiam primum aſſerunt Stoici eſſe deum, ſenſibiliter veluti infuſum eſſe per ea, quæ ſunt in aere, per cunctas animantes & arbores, per terram autem ipſam ſecundum halitum.* To which agrees not only that noted paſſage of *Virgil*, *Principio Cœlum*, &c. ——— but another, which I ſomewhat wonder learned men ſhould read with no more reflexion; ſince he there gives the ſky the very title of the high God: *Tum pater omnipotens fœcundis imbribus æther*, &c.

† *Diog. Laert.* l. vii. in *vita Zenon.*

(b) Whereas, the idolaters and infidels I ſpeak of conceived, under the name of God, a being, about which they dogmatically entertained conceptions, which, though different from one another, are much more ſo from the truth.

For firſt, moſt of them thought their God to be purely corporeal, as, beſides what *Diogenes Laertius* and others relate, I remember *Origen* doth in ſeveral places affirm. If you will believe (c) *Euſebius*, the antient Ægyptian theologers not only affirmed the ſun, moon and ſtars to the Gods, but denied incorporeal ſubſtances, or inviſible natures, to have framed the world, but only the ſun, that is diſcoverable to our eyes. And this corporiety of God ſeems manifeſtly to be the opinion of Mr. *Hobbes* and his genuine diſciples, to divers of whoſe principles and dogmata it is as congruous, as it is repugnant to religion. But ſecondly, there are others, that allowed a ſoul of the world, which was a rational and provident being, together with the corporeal part of the univerſe, eſpecially heaven, (which, I remember, *Ariſtotle* himſelf ſtyles a (d) divine body, (or, as ſome render his expreſſions, the body of God)) but withal, they held, that this being did properly inform this great maſs of the univerſe, and ſo was, indeed, a mundane ſoul. And though ſome of our late infidels (formerly pointed at in this treatiſe,) pretend to be great diſcoverers of new light in this affair; yet, as far as I am informed of their doctrine, it has much affinity with, and is little or not at all better than that, which I formerly noted out of *Lactantius* to have been aſſerted by the Stoicks, and the doctrine, which is expreſſed by *Maximus* (a Pagan) to St. *Auſtin*. *Equidem unicum eſſe deum ſummum atque magnificum, quis tam demens, tam mente captus, ut neget eſſe certiſſimum? Hujus nos virtutes per mundanum opus diffuſas multis vocabulis invocamus, quoniam nomen ejus cuncti proprium ignoremus.* Or by that famous and learned *Roman*, *Varro*, who is cited by St. *Auſtin*, to have ſaid, *Deum ſe arbitrari animam mundi, & hunc ipſum mundum eſſe deum; ſed ſicut hominem ſapientem, cum ſit ex animo & corpore, tamen ab animo dicimus ſapientem; ita mundum deum dici ab animo, cum ſit ex animo & corpore.*

(c) Præp. l. iii. c. 4.

(d) De Cœlo l. ii. c. 3.

De Civit. Dei l. vii. c. 6.

THE doctrine, by us propoſed, may, it is hoped, much conduce to juſtify ſome remarkable proceedings of divine providence againſt thoſe cavillers, that boldly cenſure it, upon the account of ſome things, that they judge to be phyſical irregularities, (for moral ones concern not this diſcourſe,) ſuch as monſters, earthquakes, floods, eruptions of volcanos, famines, *&c.* For, according to our doctrine,

I. GOD is a moſt free agent, and created the world, not out of neceſſity, but voluntarily, having framed it, as he pleaſed and thought fit, at the beginning of things, when there was no ſubſtance but himſelf, and conſequently no creature, to which he could be obliged, or by which he could be limited.

II. GOD having an underſtanding infinitely ſuperior to that of man, in extent, clearneſs, and other excellencies, he may rationally be ſuppoſed to have framed ſo great and admirable an automaton as the world, and the ſubordinate engines comprized in it, for ſeveral ends and purpoſes, ſome of them relating chiefly to his corporeal, and other to his rational creatures; of which ends he hath vouchſafed to make ſome diſcoverable by our dim reaſon, but others are probably not to be penetrated by it, but lie concealed in the deep abyſs of his unfathomable wiſdom.

III. IT ſeems not incongruous to conceive, that this moſt excellent and glorious being thought fit to order things ſo, that both his works and actions might bear ſome ſignatures, and, as it were, badges of his attributes, and eſpecially to ſtamp upon his corporeal works ſome tokens or impreſſes, diſcernible by human intellects, of his divine wiſdom; an attribute, that may advantageouſly diſcloſe itſelf to us men, by producing a vaſt multitude of things, from as few, and as ſimple, principles, and in as uniform a way, as, with congruity to his other attributes, is poſſible.

IV. ACCORDING to this ſuppoſition, it ſeems, that it became the divine author of the univerſe to give it ſuch a ſtructure, and ſuch powers, and to eſtabliſh among its parts ſuch general and conſtant laws, as beſt ſuited with his purpoſes in creating the world; and to give theſe catholic laws, and particular parts or bodies, ſuch ſubordinations to one another, and ſuch references to the original fabric of the grand ſyſtem of the world, that, on all particular occaſions, the welfare of inferior or private portions of it, ſhould be only ſo far provided for, as their welfare is conſiſtent with the general laws ſettled by God in the univerſe, and with ſuch of thoſe ends, that he propoſed to himſelf in framing it, as are more conſiderable, than the welfare of thoſe particular creatures.

(b) The error here rejected, was the opinion of many of the heathen philoſophers, and particularly of the Stoical ſect; of whoſe author * *Laertius* ſays, *De divina ſubſtantia Zeno ait mundum totum atque cœlum.* And ſeveral ethnic philoſophers, even after the light of the goſpel began to ſhine in the world, adopted the argument of the elder Stoicks, who inferred the world to be animated and rational from the nature of the human ſoul, which they thought a portion of the intelligent part of the world, that ſome of them confounded with the deity. For the Stoicks (in *Laertius*) affirm, *Mundum eſſe animale & rationale & animatum* (ἔμψυχον) *& intelligibile.* And it is added, *Mundum animatum eſſe, inde manifeſtum eſt, quod anima noſtra inde veluti avulſa ſit.* Thus *Seneca*, *Quid eſt autem cur non exiſtimes, in eo divini aliquid exiſtere, quæ dei pars eſt?* So *Plutarch*, ſpeaking of the ſoul, *Non opus ſolum dei, ſed & pars eſt; neque ab ipſo, ſed ex ipſo nata eſt.* And *Epictetus*, *anima ita alligatæ & conjunctæ deo ſunt, ut particulæ ejus ſint.*

* In Vita *Zenonis*. De Viris *Phil.* l. vii. *Epiſt.* 92. *Plutarch* in *Quæſt. Plat.* Diſſert. 1. c. 14.

UPON theſe grounds, if we ſet aſide the conſideration of miracles, as things ſupernatural, and of thoſe inſtances, wherein the providence of the great rector of the univerſe, and human affairs, is pleaſed peculiarly to interpoſe; it may be rationally ſaid, that God having an infinite underſtanding, to which all things are at once in a manner preſent, did, by virtue of it, clearly diſcern, what would happen, in conſequence of the laws by him eſtabliſhed, in all the poſſible combinations of them, and in all the junctures of circumſtances, wherein the creatures concerned in them may be found. And, that having, when all theſe things were in his proſpect, ſettled among his corporeal works general and ſtanding laws of motion ſuited to his moſt wiſe ends, it ſeems very congruous to his wiſdom, to prefer (unleſs in the newly excepted caſes) catholic laws, and higher ends, before ſubordinate ones, and uniformity in his conduct before making changes in it according to every ſort of particular emergencies: and conſequently, not to recede from the general laws he at firſt moſt wiſely eſtabliſhed, to comply with the appetites or the needs of particular creatures, or to prevent ſome ſeeming irregularities (ſuch as earthquakes, floods, famines, &c.) incommodious to them, which are no other, than ſuch, as he foreſaw would happen (as the eclipſes of the ſun and moon from time to time, the falling of ſhowers upon the ſea and ſandy deſarts, and the like muſt do, by virtue of the original diſpoſition of things,) and thought fit to ordain, or to permit, as not unſuitable to ſome or other of thoſe wiſe ends, which he may have in his all-pervading view, who either as the maker and upholder of the univerſe, or as the ſovereign rector of his rational creatures, may have ends, whether phyſical, moral, or political, (if I may be allowed ſo to diſtinguiſh and name them;) divers of which, for aught we can tell, or ſhould preſume, are known only to himſelf: whence we may argue, that ſeveral phænomena, which ſeem to us anomalous, may be very congruous or conducive to thoſe ſecret ends, and therefore are unfit to be cenſured by us, dim-ſighted mortals.

AND, indeed, the admirable wiſdom and ſkill, that, in ſome conſpicuous inſtances, the divine opificer has diſplayed in the fitting of things for ſuch ends and uſes, for which (among other purpoſes) he may rationally be ſuppoſed to have deſigned them, may juſtly perſuade us, that his ſkill would not appear inferior in reference to the reſt alſo of his corporeal works, if we could as well in theſe, as in thoſe, diſcern their particular final cauſes. As if we ſuppoſe an excellent letter about ſeveral ſubjects, and to different purpoſes, whereof ſome parts were written in plain characters, others in cyphers, beſides a third ſort of clauſes, wherein both kinds of writing were variouſly mixed, to be heedfully peruſed by a very intelligent perſon; if he finds, that thoſe paſſages, that he can underſtand, are excellently ſuited to the ſcopes, that appear to be intended in them, it is rational as well as equitable in him to conclude, that the paſſages or clauſes of the third ſort, if any of them ſeem to be inſignificant, or even to make an incongruous ſenſe, do it but becauſe of the illegible words; and that both theſe paſſages, and thoſe written altogether in cyphers, would be found no leſs worthy of the excellent * writer, than the plaineſt parts of the epiſtle, if the particular purpoſes, they were deſigned for, were as clearly diſcernable by the reader. And perhaps you will allow me to add, that by this way of ordering things ſo, that, in ſome of God's works, the ends or uſes may be manifeſt, and the exquiſite fitneſs of the means may be conſpicuous; [as the eye is manifeſtly made for ſeeing, and the parts it conſiſts of admirably fitted to make it an excellent organ of viſion] and in other, the ends deſigned ſeem to be beyond our reach; by this way, (I ſay) of managing things, the moſt wiſe author of them does both gratify our underſtandings, and make us ſenſible of the imperfection of them.

* See the Diſcourſe of Final Cauſes.

IF the repreſentation now made of providence ſerve (as I hope it may,) to reſolve ſome ſcruples about it, I know you will not think it uſeleſs to religion. And though I ſhould miſs of my aim in it, yet ſince I do not dogmatize in what I propoſe about it, but freely ſubmit my thoughts to better judgments; I hope my well-meant endeavours will be, as well as the unſucceſsful ones of abler pens have been, excuſed by the ſcarce ſuperable difficulty of the ſubject. However, what I have propoſed about providence, being written, rather to do a ſervice to theology, than as neceſſary to juſtify a diſſatisfaction with the received notion of nature, that was grounded mainly upon philoſophical objections; I hope our free inquiry may, though this ſecond uſe of it ſhould be quite laid aſide, be thought not unſerviceable to religion; ſince the firſt uſe of it (above delivered) does not depend on my notions about providence, no more than the third, which my prolixity about the former makes it fit I ſhould in few words diſpatch.

III. THE laſt then, but not the leaſt, ſervice, I hope, our doctrine may do religion, is, that it may induce men to pay their admiration, their praiſes, and their thanks, directly to God himſelf, who is the true and only creator of the ſun, moon, earth, and thoſe other creatures, that men are wont to call the works of nature. And in this way of expreſſing their veneration of the true God, (who in the holy ſcripture ſtiles himſelf a *jealous God*, Exod. xx. 5.) and their gratitude to him, they are warranted by the examples of the antient people of God, the *Iſraelites*, and not only by the inſpired perſons of the *Old Teſtament*, but by the promulgators of the *New Teſtament*, and even by the cœleſtial ſpirits; who, in the laſt book of it, are introduced praiſing and thanking God himſelf for his mundane works, without taking

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ing any notice of his pretended viceregent, nature.

The CONCLUSION.

AND now, dear *Eleutherius*, you have the whole bundle of thoſe papers, that I found and tacked together, (for they are not all, that I have written) touching my free inquiry into the received notion of nature; at the cloſe of which eſſay, I muſt crave leave to repreſent two or three things about it.

1. SINCE this treatiſe pretends to be but an inquiry, I hope that any diſcourſes or expreſſions, that you have found dogmatically delivered, about queſtions of great moment or difficulty, will be interpreted with congruity to the title and avowed ſcope of this treatiſe; and that ſo favourable a reader, as *Eleutherius*, will conſider, that it was very difficult, in the heat of diſcourſe, never to forget the reſerves, that the title may ſuggeſt, eſpecially ſince, on divers occaſions, I could not have ſpoken with thoſe reſerves, without much enervating my diſcourſe, and being, by reſtrictions and other cautious expreſſions, tedious or troubleſome to you. But this, as I lately intimated, is to be underſtood of things of great moment or difficulty; for otherwiſe, there are divers notions, ſuppoſitions, and explanations, in the vulgarly received doctrine of nature, and her phenomena, which I take to be either ſo precarious, or ſo unintelligible, or ſo incongruous, or ſo inſufficient, that I ſcruple not to own, that I am diſſatisfied with them, and reject them.

2. THOUGH, upon a tranſient view of theſe papers, I find, that ſeveral parcels, that came firſt into my hands, having been laid and faſtened together, (to keep them from being loſt, as others had already been) before the others were lighted on, ſome of them will be met with in places, that are not the moſt proper for them; yet haſte and ſickneſs made me rather venture on your good nature for the pardon of a venial fault, than put myſelf to the trouble of altering the order of theſe papers, and ſubſtituting new tranſitions and connections, in the room of thoſe, with which I formerly made up the chaſms and incoherency of the tract you now receive. And if the notions and reaſonings be themſelves ſolid, they will not need the aſſiſtance of an exact method to obtain the aſſent of ſo diſcerning a reader, as they are preſented to; upon the ſcore of whoſe benignity it is hoped, that the former advertiſement may likewiſe paſs for an excuſe, if the ſame things, for ſubſtance, be found more than once in a tract written at very diſtant times, and in very differing circumſtances. For, beſides that ſuch ſeeming repetitions will not (if I be not miſtaken) frequently occur, and will, for the moſt part, be found, by being variouſly expreſſed, to elucidate or ſtrengthen the thought or argument they belong to; and beſides that the novelty and difficulty of ſome points may have made it needful, not only to diſplay, but to inculcate them; beſides theſe things, I ſay, it is very poſſible, that the ſame notion may ſerve to explicate or prove ſeveral truths, and therefore may, without impertinency, be made uſe of in more than one part of our treatiſe. And if our inquiry ſhall be thought worthy to be tranſcribed, and preſented to you a ſecond time, after I ſhall have reviewed it, and heard objections againſt it, and conſidered the things, that either you, or I myſelf, may find fault with in it; it is very poſſible, that (if God grant me life and leiſure,) this tract, which, in its preſent dreſs, I deſire you would look on but as an apparatus (towards a more full and orderly treatiſe) may appear before you in a leſs unaccurate method; and that my ſecond thoughts may prove more correct, more mature, or better backed and fortified, than my firſt.

3. THE ſubject of my inquiry being of great extent, as well as conſequence, it obliged me to conſider, and treat of many things, (as philoſophical, medical, theological, *&c.*) and, among them, of divers, that are not at all of eaſy ſpeculation; and I found it the more difficult to handle them well, becauſe the attempt I have ventured upon being new, and to be proſecuted by diſcourſe, many of them oppoſite to the general ſentiments of mankind, I was not to expect much aſſiſtance from any thing, but truth and reaſon. And therefore, as I cannot preſume not to need your indulgence, ſo I cannot deſpair of obtaining it, if in this my firſt eſſay, upon a variety of difficult points, I have not always hit the mark, and as happily found the truth as ſincerely ſought it. But if you ſhall (which it is very probable you will) find, that I have fallen into ſome errors, it will be but one trouble for you, to make me diſcern them, and forſake them, (eſpecially any, wherein religion may be concerned) which I have, by way of previſion, made it the more eaſy for myſelf to do; becauſe (if my ſtyle have not wronged my intentions,) I have written this diſcourſe, rather like a doubting ſeeker of truth, than a man confident, that he has found it.

THE
MARTYRDOM
OF
THEODORA,
AND OF
DIDYMUS.

Such an ACCOUNT of the following BOOK, ſent with it to a FRIEND, as may ſerve inſtead of a PREFACE.

TO convince you, Sir, how much more I am concerned to have you think I can obey well, than write well, I venture to ſend you the account, (as imperfect and unpoliſhed as it is) that you are pleaſed to command of the laſt hours of *Theodora*; but I muſt beg your leave to accompany it with another account (though but a ſhort one) how I came to meddle with this ſubject, and why what I preſent you about it, is ſo much maimed, and has no more uniformity.

HAVING had occaſion many years ago to turn over a martyrology, and ſome other books, that related to the ſufferings of the primitive Chriſtians, I chanced to light on thoſe of a virgin, who, though (to my wonder) ſhe was left unnamed by the other writers, that mentioned her, ſeemed plainly to be the ſame, that is by one of them expreſly called *Theodora*. I own, I was not a little affected, at the reading of ſuch moving and uncommon adventures as hers, and finding her ſtory to be related by the author, that named both her and her lover, not only very ſuccinctly and imperfectly, but very dully too; I found myſelf tempted ſo to enlarge this ſtory, as that it might be contrived into a ſomewhat voluminous romance: but upon ſecond thoughts, it appeared incongruous to turn a martyr into a nymph or an amazon; and I conſidered too, that (to omit what elſe might be objected againſt that ſort of compoſures) as true pearls are cordials and antidotes, which counterfeit ones, how fine ſoever they may appear, are not; ſo true examples do arm and fortify the mind far more efficaciouſly, than imaginary or fictitious ones can do; and the fabulous labours of *Hercules*, and exploits of *Arthur* of *Britain*, will never make men aſpire to heroic virtue half ſo powerfully, as the real examples of courage and gallantry afforded by *Jonathan*, *Cæſar*, or the *Black Prince*. But yet, thinking it great pity, that ſo ſhining a virtue as *Theodora*'s ſhould prove exemplary, but to her own time, and to one city; and remembring, that ſoon after the age, which ſhe ennobled, it was counted among the primitive Chriſtians an act of piety, to build fair monuments, upon the formerly abject graves of the martyrs, to repay, by honours due to their memories, the indignities and diſgraces they had ſuffered in their perſons; I thought fit to try, if I could reſcue from more unſkilful hands than even mine a ſtory, that abundantly deſerved to be well told.

BUT, upon further thoughts, I ſoon foreſaw, that this taſk was not more worthy to be undertaken, than it would prove difficult to be well performed: for the martyrologiſt having allowed ſcarce one whole page to a relation, that perhaps merited a volume, had left ſo many chaſms, and ſo many neceſſary things unmentioned, that I plainly perceived I wanted a far greater number of circumſtances, than that he had ſupplied me with, to make up ſo maimed a ſtory tolerably compleat. And as the relation denied me matter enough to work upon, ſo the nature of the ſubject refuſed moſt of thoſe embelliſhments, which in other themes, where young gallants and fair ladies are the chief actors, are wont to ſupply the deficiencies of the matter. Beſides,

ſides, my taſk was not near ſo eaſy, as it would have been, if I had been only to recite the intrigues of an amour, with the liberty to feign ſurprizing adventures to adorn the hiſtorical part of the account, and to make a lover ſpeak as paſſionately as I could, and his miſtreſs as kindly, as the indulgenteſt laws of decency would permit. But I was to introduce a Chriſtian and pious lover, who was to contain the expreſſions of his flame within the narrow bounds of his religion; and a virgin, who, being as modeſt and diſcreet as handſome, and as devout as either, was to own an high eſteem for an excellent lover, and an uncommon gratitude to a tranſcendent benefactor, without intrenching either upon her virtue, or her reſervedneſs. And I perceived the difficulty of my taſk would be encreaſed, by that of reconciling *Theodora*'s ſcrupulouſneſs to the humours of ſome young perſons of quality of either ſex, who were earneſt to engage my pen on this occaſion, and would expect, that I ſhould make *Theodora* more kind, than I thought her great piety and ſtrict modeſty would permit. But for all this, the eſteem I had for the fair martyr's excellencies, and the compliance I had for thoſe, that deſired to receive an account of ſo rare a perſon's actions and ſufferings, made me reſolve to try what I could do; which I adventured upon with the leſs reluctancy, becauſe, though I eſteemed it a kind of profaneneſs to transform a piece of martyrology into a romance, yet I thought it allowable enough, where a narrative was written ſo conciſely, and left ſo imperfect, as that I had to deſcant upon, to make ſuch ſupplements of circumſtances, as were not improbable in the nature of the thing, and were little leſs than neceſſary to the clearneſs and entireneſs of the ſtory, and the decent connection of the parts it ſhould conſiſt of. I ſuppoſed too, that I need not ſcruple to lend ſpeeches to the perſons I brought upon the ſtage, provided they were ſuitable to the ſpeakers, and occaſions; ſince I was warranted by the examples of *Livy*, *Plutarch*, and other grave and judicious hiſtorians, who make no ſcruple to give us ſet orations of their own framing, and ſometimes put them into the mouths of generals at the head of their armies, juſt going to give battle; though at ſuch times the hurry and diſtraction, that both they and their auditors muſt be in, muſt make it very unlikely, either that they ſhould make elaborate ſpeeches, or their hearers mind and remember them well enough to repeat them to the hiſtorians.

Encouraged by theſe liberties, which I thought I might juſtly allow myſelf, I drew up, as well as I could, what you have been told I wrote about *Theodora*. This I thought fit to divide into two parts, in the firſt whereof, (which was leſs remote from being romantic) I gave ſomewhat at large the characters of them both; I mentioned the riſe and progreſs of *Didymus*'s love; the degeneracy of the then Chriſtians, which provoked divine providence to expoſe them to a very bloody perſecution: I declared, how *Theodora* being involved in it, was brought before the preſident of *Antioch*; how ſhe reſolutely owned her religion before him, anſwered his arguments, and reſiſted both his promiſes and his menaces; how thereupon the judge doomed her either to ſacrifice, or to be proſtituted in the public ſtews; how ſhe, after an eager debate in her own mind, refuſing to offer ſacrifice, was, (notwithſtanding her ſilence) led away to the infamous place; how being ſhut up there alone in a room, ſhe employed the little time, that was granted her, to conſider, whether ſhe would yet turn incenſe to the Roman idols, in fervent prayer to the true God, for a reſcue of her purity, not her life; in order whereunto, ſhe deſigned, and hoped by reſiſtance and contumelies, to provoke her firſt aſſailant, to become her murderer, rather than her raviſher.

These were the chief contents of the firſt book. Thoſe of the ſecond were more hiſtorical, and conſiſted of an account of the laſt hours of her life, and particularly of thoſe ſufferings, that ended in her and *Didymus*'s glorious martyrdom. This piece having been peruſed by thoſe, for whoſe ſake I wrote it, was ſo fortunate, that it having, without my leave, been ventured into ſeveral hands, as a book of a nameleſs and unknown author, it was lucky enough to be, by ſome indulgent readers, attributed to one, and by ſome to another, of the two perſons, that were at that time counted the beſt writers of diſguiſed hiſtories. But among the many hands it paſſed through, it ſeems it fell into ſome, out of which a great part of the looſe ſheets, (which were not bound in a book, but only tacked together) were not to be retrieved; whether it were by the negligence, or the contempt, that ſome had of ſo unpoliſhed a work; or whether there were ſome fatality in the buſineſs, that *Theodora*'s ſufferings ſhould outlive her, and her ſtory be as ill uſed as her perſon had been. This loſs, (if it can deſerve that name) I did not much regret, ſince I intended not to make the loſt papers publick, and had received much greater approbation and thanks, than they merited, from the particular perſons they were deſigned for. But after I had for many years worn out, not only the ſenſe, but the memory of this loſs, it was made more troubleſome to me, than ever it was at firſt, by the earneſt ſolicitations of ſome eminent perſons, that had a great power over me, and ſome of them the repute of great judges of this kind of compoſures; for having ſeen ſeveral ſheets, that I accidentally lighted on in tumbling over ſome long neglected papers, they obliged me to cauſe thoſe old rude ſheets to be tranſcribed; and though almoſt all the firſt book was wanting, (upon which account, I could not be removed from my reſolution not to trouble myſelf about it) yet there was ſo much of the ſecond book, but in parts no way coherent, little by little retrieved, that a pretence was afforded to preſs me to repair thoſe breaches, and reſtore out of my memory, or otherwiſe, a piece, which they would needs perſwade me might do ſome good, by rendering virtue amiable, and recommending piety to a ſort of readers, that are much more affected by ſhining examples, and pathetical expreſſions, than by dry precepts, and grave diſcourſes.

If ſome of your more ſcrupulous friends ſhall object, that I have mentioned *Theodora*'s beauty more often and advantageouſly, and repreſented her lover's paſſion more pathetically, than the ſubject of the ſtory exacted, and the truth required in hiſtory would warrant; I ſhall not altogether deny the charge, being rather content to have it thought, that a youthful and heated fancy tranſported my pen ſomewhat beyond the narrow bounds of hiſtory, than that ſo pious a perſon, as *Didymus*, did not keep both his flame, and the expreſſions of it, within the limits of reaſon and religion. But though I pretend not to juſtify all that has been ſaid in the ſtrain of an encomiaſt, or a lover; yet I hope, that I may much extenuate, if not excuſe it, by repreſenting ſuch things as theſe.

That I have been careful, that *Theodora* ſhould not be made to do any thing, that, the great obligations ſhe had to her reſcuer conſidered, do intrench either upon her piety, or her virtue, or ſo much as upon her reſervedneſs.

That as for *Didymus*, I might ſay, that probably he thought thoſe celebrations, that would have been flattery to another lady, were but juſtice to a perſon ſo extraordinary, and ſo accompliſhed, as his miſtreſs; and that he thought it allowable, not to ſuppreſs the chaſt effects of a paſſion, that has not only been incident to heroes, but perhaps helped to make them ſuch. But I will rather ſay, that thoſe only are like to find much fault with his expreſſions, who conſider not, how free they are from any degree of prophaneneſs or immodeſty; and who are not accuſtomed to the reading of ſtories, where lovers are introduced, and made to praiſe and compliment in a far more bold and romantick way, than I allowed myſelf in the following paper: in which, all the deference, wherewith *Irene* as well as *Didymus* treat *Theodora*, may be accounted for by this; that I remembered to have, in ſome author or other, found mention made of a perſon about *Diocleſian*'s time, whom I took for our martyr, that was intimated to be of high quality, if not a princeſs, which title I had without ſcruple given her, if I had been half as ſure, that ſhe was a princeſs, as that ſhe deſerved to be one.

That perhaps I was not unwilling, both to ſhew the perſons I wrote for, that one might have glittering ideas of beauty, without being dazzled by them; and alſo to convince them, that high compliments, and paſſionate expreſſions, are no certain marks of his being really ſmitten (to ſpeak in a lover's phraſe) that can employ them; ſince I retained my wonted freedom of mind, while I was writing, and preſented them, by the mouth of *Didymus*, but what fancy, not paſſion indited.

And laſtly, I was induced to allow myſelf a more faſhionable ſtile, than would perhaps be ſuitable to a meer ſermon, or book of divinity; becauſe I feared, that the youthful perſons of quality of both ſexes, that I was chiefly to regard, would ſcarce be ſufficiently affected by unfortunate virtue, if the interweaving of paſſages relating to beauty and love did not help to make the tragical ſtory delightful, and the excellent ſufferers piety amiable.

If it be objected, that in ſome of the diſcourſes of the two martyrs there are paſſages, that argue more knowledge, than is likely to have been found in lay perſons no elder than they; I anſwer, that ſuch diſcourſes indeed were ſomewhat ſtrange, if they were aſcribed to a young gallant, and a younger lady, of our degenerate times, wherein ſo many perſons of that ſort make diverſion their grand buſineſs, and, having as little leiſure, as concern, to mind any thing, but their pleaſures and petty intereſts, think it their priviledge to know little of religion, and leave to meaner people the ſtudy of things ſerious and uſeful. But though among this ſort of people it were ſo difficult to find many, that would emulate ſuch knowledge and virtue, as ſhined in *Theodora*, that I fear they would not ſo much as believe them; yet among better qualified judges the lately propoſed objection will be of no great force, if it be conſidered, that *Didymus* and *Theodora* lived in the primitive and devout times of the church, and in the *Roman* empire, when the Chriſtian religion was as diligently taught by excellent divines, as frequently oppoſed by arguments, and violently aſſaulted by perſecutions. Upon which ſcores the zealous candidates of martyrdom, many of which obtained the crown of it even in their greener age, were early and ſkilfully inſtructed in the truths of their own religion, and furniſhed with good arguments, both to defend it, and confute the erroneous opinions and impious worſhips of their heathen adverſaries: nor is it any wonder, that they ſhould think that religion worth ſtudying, that they thought worth dying for. I will not here examine, whether the ignorance wont to be imputed to women be their fault, or that of their accuſers; and whether it is any natural want of capacity, or rather want of inſtruction, that keeps moſt of them from knowledge, though this regards not ſexes. But without inquiry, whether it be not our intereſt, or our envy, that makes women, what we are wont to decry them for being; I ſhall not ſcruple to own, that I have ſometimes had the honour to converſe with ladies, that convinced me, that, to attain to a great proficiency of knowledge, it is not neceſſary ry to be a doctor of divinity, or ſo much as a man, ſince they diſcourſed of divine things with no leſs wit than piety. And to return to our martyr, if we may judge by the effects, we may reaſonably ſuppoſe, that our virgin's parents not only thought it their duty, but took much pleaſure, to cultivate ſo excellent and promiſing a ſubject as their fair daughter; ſince great advantages of nature, and general grace, ſhould rather invite, than excuſe, improvements by education; as even the garden of *Eden*, though an admirably fertile ſoil, and planted by God's own hands, was not ſo left to itſelf, but that *Adam* was appointed to dreſs it, and to keep it. And if the diſcourſes of our martyrs are ſometimes leſs ſhort, than they might have been made; I hope it may be ſome excuſe, that I was not unwilling, to lay hold now and then of the riſes afforded me by ſome occaſions, to ſhew, that romantick ſubjects are not, as too many perſons of quality think them, the only ones, that may be treated of in a gentleman-like ſtile; and that even ſome noble queſtions in divinity, and ſome of the ſeverer dictates of the Chriſtian morals, may be diſcourſed of, without the harſhneſs of the ſchool terms, or the downright plainneſs of ſome better meant, than penned, books of theology and devotion.

It is like, Sir, you will think it ſtrange, that I make ſo pious a perſon, as *Theodora*, offer her breaſt to *Didymus*'s ſword, and, by ſoliciting him to kill her, tempt him to an action, which would make her guilty of a murder, and make him greatly acceſſory to it. But poſſibly her action would not appear very ſtrange, if we were not too inclinable to eſtimate the affairs of paſt times, and remote regions, by the opinions and cuſtoms of our own age and countries. For whatever we now juſtly think of the ſinfulneſs of deſtroying a man's ſelf, whether immediately or otherwiſe, yet I muſt not deny, but that divers of the ancient Chriſtians thought it not criminal, when it was neceſſary for the preſervation of chaſtity: and, if I much miſremember not, St. *Jerom* himſelf, where he ſpeaks of the unlawfulneſs of ſelf-deſtroying, intimates, that he excepts the caſe of an inevitable danger of a rape. But my chief anſwer is, that having found the virgin martyr's propoſal expreſly delivered by the author I was to follow, I judged it the part of an hiſtorian not to ſuppreſs it; which I acknowledge I the father declined to do, becauſe *Theodora's* offer was a noble evincement both of her gratitude and her generoſity. And therefore, inſtead of omitting ſo conſiderable an action of hers, I choſe rather to ſet my thoughts a work, to find a plauſible colour for it; which whether I have happily done, by ſupplying her with the example of a prophet, who, though he would not caſt himſelf into the ſea, yet ſolicited others to caſt him, (and that having firſt bound him) I muſt leave you to judge.

I freely confeſs, Sir, that, if the following piece had been written by one, that I were fond of cenſuring, I could myſelf find enough in it to criticize upon; and ſhould object againſt it, beſides the want of uniformity throughout, that, if judged of by the ſtrict rules of art, it ought to paſs for an irregular piece. And therefore I ſhall not wonder, if nicer criticks, and more verſed in exquiſite compoſures, than I pretend to be, ſhall find fault with this artleſs one of mine. But the reception, that the following papers met with, from the perſons, for whom they were chiefly written, affords me the conſolation derivable from the ingenious ſaying of that excellent wit, who declared, he had rather the diſhes ſerved up at his treat ſhould pleaſe the gueſts, than the cooks. And I might ſay too, that ſome of the paſſages, that may meet with cenſure, would perhaps eſcape it, if in writing this book many years ago, I had not had ſome aims, that I then thought more fit to be purſued, than I now do to be declared. Yet I will not here diſſemble, that I know it may be thought by ſome, that this paper ſhould have conſiſted leſs of converſations, and more of narratives. But I choſe the way of writing I have employed, partly becauſe the authors I met with furniſhed me with ſo very few matters of fact, that, if I would have confined myſelf to relations, I muſt have comprized this piece in a very few pages, and have finiſhed it preſently after I had begun it; and partly too, (and indeed much more) becauſe (as I lately began to intimate) my chief deſign was not ſo much to perform the office of a meer hiſtorian, as to take riſes, from the ſeveral circumſtances I ſhould relate, to convey unperceivedly into the minds of thoſe young perſons of quality, for whom I wrote, ſentiments of true piety and virtue: and theſe I thought would not ſo happily gain admittance and entertainment, if they were preſented in a ſcholar-like diſcourſe, or a profeſſed book of devotion, as when they were taken, not from common places, but from the nature of the things and perſons introduced, and without formality inſtilled by the occaſional diſcourſes of a young gentleman and fair lady, for whom the beauty and the merit aſcribed to the ſpeakers had given the hearers a great eſteem and kindneſs. And I ſhall not ſcruple to own, that I, who value time above moſt other things, did not think it worth the expence of mine, to give myſelf the trouble of writing a book, only to give others a divertiſement in reading it. And whilſt I was converſing with ſuch excellent company, as our noble martyrs, and meditating on ſuch ſerious ſubjects, as are death, and the worth of that heavenly religion, for whoſe ſake they deſpiſed it; I found myſelf incited, and thought myſelf obliged, to aim leſs at the pleaſing of ſome few nice exactors of regularity, than to poſſeſs many readers with high and noble ſentiments of the Chriſtian religion, and the

the ſublime dictates of it; and thereby both elevate their minds to a generous contempt of all they can loſe and ſuffer for it, and fill them with bright ideas of heroick virtue, and of the much brighter glories, that will crown it. By ſuch reflections I was induced not to omit ſome paſſages, that ſeemed likely to further the main ends I purſued, though I foreſaw, that perhaps ſome rigid judges would ſay, that they might have been ſpared. For as I writ not a romance, wherein authors are wont, to aim no higher, than to delight the delicate readers, and eſcape the critical ones, by making their compoſures diverting and regular; ſo I preſumed, that to employ a more uſeful, though leſs faſhionable way of writing, was allowable for me, who ought to endeavour in ſuch a piece as this, rather to propoſe patterns of virtue, than models of ſkill or eloquence; and to think it more ſucceſsful, if the readers ſhall, upon peruſing it, imitate our excellent martyrs piety, than if they ſhould only applaud their hiſtory; which both as to ſtile, and reaſonings is freely ſubmitted to your judgment by

SIR,

Your moſt, &c.

The MARTYRDOM of THEODORA.

BOOK II.

CHAP. I.

THOUGH it may ſeem ill natured to leave the chaſt *Theodora* in ſo deplorable a condition, yet it is requiſite to do ſo for a while, that we may learn what was attempted to reſcue her out of it.

It is not to be doubted, but that *Didymus* was not long kept a ſtranger to the barbarous uſage ſhe had ſuffered. That of ſo illuſtrious a lady could not but make a great noiſe, and reach a multitude of ears, and eſpecially thoſe of ſo concerned a perſon as *Didymus*; the wounds of lovers tender hearts giving them oftentimes ſecret preſages of approaching misfortunes relating to their love; as many other wounded men have the unhappy priviledge of being able, by feeling of pain, to diſcern ſuch approaches of ill weather, as affect not unhurt men.

Didymus therefore being quickly too much aſcertained of the unwelcome news of the diſtreſs of his fair miſtreſs, was too generous a lover to deliberate, whether he ſhould expoſe his life for her reſcue; his deliberation being only about the means, how to make ſo difficult an attempt a proſperous one. In order to this he happily finds out one of the officers of the guards, that were placed about the infamous houſe, to which *Theodora* was condemned, who having been his fellow ſoldier in the Roman armies, he hoped would, either for the ſake of virtue or of *Didymus*, be prevailed with to further ſo handſome a deſign as his.

Wherefore addreſſing himſelf to this commander, with a very obliging and yet civil freedom: Generous Septimius, ſays he, I cannot but look upon it as one of the chief advantages I have obtained by venturing my life in the *Roman* camps, that I had the happineſs to be acquainted with you there, and to be a ſpectator of your gallantry; which did not only then raiſe me to a deſire of imitating it, but allows me now to own a requeſt to you, that none but a gallant perſon ought to be entruſted with, or would eaſily grant. Generous *Didymus*, replies the *Roman*, when I accompanied you in following our propitious eagles, I found ſo great a contentment in your acquaintance, and ſo ſtrong a ſpur to glory in your examples, that I looked upon the advantage of having been your fellow ſoldier, as preferable to the honour of leading the moſt numerous troops I may at any time command; and I ſhall think all the hazards I then expoſed myſelf to, abundantly rewarded, if any power they have procured me may enable me to do you ſervice: tell me then frankly, in what caſe, and after what manner, you would have it employed for you; and as I aſſure myſelf, that ſo virtuous a friend as *Didymus* will deſire nothing but what is juſt, ſo he may aſſure himſelf not to be refuſed any ſervice, that is but dangerous.

Our lover emboldened by ſo encouraging a declaration firſt made him a very grateful acknowledgement for it, and then proceeded to ſay. If you have ever had the happineſs to be acquainted with *Theodora*, or ſo much as to have ſeen her, it would be needleſs, as well as improper, for me to offer at giving you a character of her, which you muſt needs think injurious to her: but if you have not, the ſhortneſs of the time will only permit me to aſſure you, that not only ſhe has given me thoſe ſentiments of her excellencies, that I never had, nor ever thought myſelf capable of having, for any of her ſex; but that in other perſons ſtrangely indiſpoſed to admit ſuch impreſſions, ſhe has often excited ſuch wonder and ſuch flames, as very rarely have been produced in other men, and perhaps, more rarely been merited by other women.

This admirable perſon, for exerciſing among other virtues, that of an invincible conſtancy to her religion, and refuſing to ſacrifice to *Venus*, *Flora*, and ſome other of thoſe deities, whom her profeſſion might, though her religion did not, exempt from adoring, is by your ſavage preſident condemned to be expoſed to the publick luſt; and a party of thoſe gallant Roman ſoldiers, that uſe to be ſo gloriouſly led on by you, to win battles, conquer kingdoms, and enlarge at once the fame and limits of the empire, are now employed to captivate innocent virgins, and defend their brutiſh raviſhers. You may eaſily gueſs by this, continues he, that my requeſt is like to prove an earneſt one; that you would pleaſe to treat with ſome of thoſe ſoldiers of yours, in whom you think you have the greateſt intereſt, and diſpoſe them to aſſiſt me in reſcuing *Theodora* out of ſo infamous a priſon, and accept from me greater recompences for doing a handſome action, than they can expect from the preſident, for doing a barbarous one. I hope I need not tell you, in the haſte this affair requires, that all poſſible care will be taken to keep you from being endangered by *Theodora*'s deliverance; nor will I add, how unexpreſſible an obligation you will lay on me, to heighten my gratitude to ſome proportion to your favours; becauſe I know it muſt neceſſarily fall ſhort of them, and are due to a perſon, that loves to do gallant actions for their own ſake, and had rather have great debts of gratitude remain due to him, than paid to him: wherefore I ſhall only mind you, that the time is ſo ſhort, that if your aſſiſtance be not as quick as obliging, I fear it will be as ineffectual. I ſhall quicken you only by aſſuring you, that when you act for the accompliſhed *Theodora*, you act for a perſon, that has a right to all that beauty and virtue can give one a title to.

WITH the ſame freedom, replies *Septimius*, with which you have owned to me your religion, I declare to you, that mine is that of my country, and my anceſtors; and that I worſhip thoſe propitious deities, that have made the Romans the conquerors of the world, and rewarded thoſe, that adored them, with an univerſal monarchy. But though I exceedingly approve ſo triumphant a religion, yet I confeſs to you, that I do not like the ways, that the preſident takes to propagate it; ſuch cruel methods being apt to make the world ſuſpect, that our beſt argument is force; and whilſt the perſecutors think it a glorious thing to ſee the temples filled at any rate, I had rather ſee in them fewer but ſincere votaries, than have them thronged with ſuch puſillanimous diſſemblers, as would not come in, unleſs they were ſcared in thither. And though terrors and torments work ſometimes upon the weaker ſort of Chriſtians, yet the more reſolute do ſo often deſpiſe them, that our perſecutions convert not thoſe unhappy perſons, but frequently ſtagger many of our own; and I confeſs freely to you, *Didymus*, that all the Chriſtians arguments work leſs with me, than our inhuman manner of confuting them. But I do not only diſapprove, but deteſt, this inhuman practice of our preſident, which makes him loſe not the reſpect only and the pity, but the common humanity we owe to women, and think to do the goddeſſes a ſervice by diſgracing their faireſt images here below with the moſt ſhameful of blemiſhes. I cannot bring myſelf to imagine, that ſuch gentle deities can like ſuch barbarous worſhippers, who not only immolate to them the lives of men, but, what is far more precious, the virtue and honour of women; for if I could believe they like ſuch ſacrifices, I ſhould think them unworthy of any ſacrifice at all. You will eaſily therefore, *Didymus*, credit me, that I was abſent, when my ſoldiers were put by the inſolent judge upon ſo mean an employment. He durſt not have offered to have obtruded it upon them, had I been there; or if he had, I had dared to uſe him as his inſolence had deſerved. But without loſing time in paſſionate expoſtulations, about things made remedileſs by being paſt, let us ſpeedily apply ourſelves to the reſcue of *Theodora*. For, though I have heard ſtrange things of her, and ſuch as made me think fame a great flatterer, if not a frontleſs liar, yet I believe the reports about *Theodora*, as I believe the Delphick oracles, now that I find ſo undeniable a teſtimony of her merit, as her being your miſtreſs. I will therefore without delay prepare ſome ſoldiers to aſſiſt you in her reſcue, and I cannot doubt the ſucceſs in an attempt made to ſerve a diſtreſt beauty, and a generous friend. If there be occaſion, you need not doubt of my more openly appearing for you; for how highly ſoever ſuch an action may provoke the preſident, or even the Emperor, I hope to let you ſee, that you have truſted a Roman, a perſon, that had rather be the object, than the miniſter of their cruelties, and would not be acceſſary to ſuch a miſemployment of abſolute power, to be made a ſharer in it.

As ſoon as *Septimius* had ended theſe words, he did, to prevent thoſe acknowledgements he ſaw *Didymus* was about to make him, take that gallant youth by the hand; and leading him towards the place, where he expected to find the ſoldiers he moſt confided in, he entertained him in the way about the hopefulleſt expedients for the compaſſing of his admirable miſtreſs's reſcue. And having afterwards ſent for the two perſons he thought likelieſt to be prevailed on, to a convenient place, near to that, to which they had brought *Theodora*; he briefly, but pathetically, declaring to them, how much the brave *Didymus* was his friend, and how much he deſerved to be ſo, enflamed them with indignation at the ſavage preſident's diſgracing them, by ſo infamous an employment, as they were now about; and then aſſured them of rewards from *Didymus*, ſuitable to the liberality of ſo generous a perſon: after which withdrawing himſelf to give *Didymus* a ſhort account, how far he had proceeded, he left the reſt to be com-

pleated

pleaſed by him; who, prompted by his native liberality, and his high concern, did not ſtay to cheapen his miſtreſs's liberty, but, with the haſty paſſion of a lover, proffered them more than even *Septimius*'s promiſes gave them reaſon to expect; nor would he have declined to embrace any articles of agreement, they could have propoſed, though the parting with his life had been one, ſo *Theodora*'s deliverance were another.

The ſenſe theſe ſoldiers had of the affront put on them by the preſident, joined with the ambition they had to pleaſe their loved commander, and the gratitude his friends profuſe bounty had newly obliged them to, made them quickly accommodate *Didymus* with a military habit, and prepare ſome of their comrades to allow him the firſt admittance into her chamber; partly by ſharing ſome of the newly received preſents among them, and probably by repreſenting him to them, when thus prepared, as a perſon, who, having been paſſionately in love with *Theodora*, and been ſcornfully ſlighted by her, was deſirous, at any rate, to ſatisfy at once his appetite and his revenge. And, by this means, before that ſhort time was expired, that had been as an act of grace, allowed the diſconſolate virgin, to deliberate, whether ſhe would yet comply with the judge, an entrance into her chamber was permitted to her lover; who (in order not only to his preſent, but further deſign) had purpoſely cloſed the vizor of his helmet; upon which ſcore, not being knowable by his fair miſtreſs, he met with from her the reception we have formerly related.

CHAP. II.

THOUGH in the ſad condition, wherein our diſguiſed lover found his deſolate miſtreſs, her ſorrow and her fears did ſomewhat cloud her beauty, yet they could not hinder her looks from being ſo charming and majeſtic, as to create leſs pity than reſpect. Wherefore with geſtures, wherein this was as viſible as he could make it, he told her, without approaching too near, Do not, madam, I beſeech you, add to your other troubles, the apprehenſion, that becauſe I appear in the circumſtances of a raviſher, I come to commit a rape. *Theodora* is ſo great an ornament to the Chriſtian religion, and her purity is an ornament ſo dear to *Theodora*, that heaven will not permit, either that *Antioch* ſhould be robbed of one, or ſhe of the other; and therefore that providence, which you have ſo generouſly truſted, has ſent me to your reſcue, which, after the care I have taken to diſpoſe things without doors, it will not be difficult to compaſs, if you pleaſe to make uſe of the military habit I have brought hither, to diſguiſe and convey yourſelf hence. Nor need you be ſolicitous, what will become of me, for I am under the ſame care of the ſame providence, that now juſtifies your reliance on it, by providing for your eſcape: and I, that found means to come in hither, may be ſucceſsful in attempting a retreat, or, if I ſhould not ſucceed in it, I ſhall not miſs the joy of paying my duty, where I had the moſt deſire and cauſe to do it, and ſhall leave the world with the ſatisfaction of having highly obliged it, by the preſervation of the moſt accompliſhed perſon in it. And, madam, (continues *Didymus*) that you may not doubt the willingneſs, or the intentions, wherewith this offer is made you, be pleaſed to know, that it comes from the now fortunate *Didymus*, who juſtly thinks, that in aſpiring to your acceptance of it, he does leſs proffer a ſervice, than beg a favour, that will not be only a full recompence, but a high obligation.

The name of *Didymus*, and diſcourſe ſo ſuitable to it, made by him, that aſſumed it, ſoon diſſipated the diſmal apprehenſions his habit and her circumſtances had given her: ſhe knew ſo well his courage, his virtue, and his love, that nothing unlawful or mean, was to be feared; but the boldeſt things, if they were as noble as hazardous, might juſtly be expected from him; ſo that this attempt did perhaps as much oblige her, as it ſurprized her. Wherefore as ſoon as ſhe had recompoſed her lately diſordered thoughts, ſhe told him, with looks ſerene enough to let him ſee, how much ſhe truſted him; This action, generous *Didymus*, is of a nature ſo extraordinary, that my ingratitude would be ſo too, if my ſenſe of it were not. To own and reſcue a perſecuted and affronted maid, and to do it with more hazard than you need run in the Roman armies, to purchaſe fame and honours, is an action ſo diſintereſted, and ſo unexampled, that I want words to celebrate it, as well as merit to deſerve it, and power to requite it: but I admire ſo rare an effect of virtue, (continues ſhe) can conſent to the deſtruction of its author. No, generous *Didymus*, it is enough, that the virtues of Chriſtians be treated as crimes by the Romans; they muſt not meet the like uſage from *Theodora*: ſhe muſt not purchaſe a life, that ſhe values as little herſelf as others have cauſe to do, at ſo high a rate, as your partial charity perſuades you to ſet upon it; for even thoſe, that do now moſt pity me, would repine at the preſervation of my life, if it ſhould coſt that of a hero; eſpecially, if I ſhould deſignedly be acceſſary to ſo great a loſs; which accompanied with a public indignation, and my own reproaches for my ingratitude, would certainly make that life a burden to me, that at ſo dear a rate you would preſerve as a bleſſing. But——

Here *Theodora* was going to proceed, when her grieved lover fearing, that if ſhe did ſo, ſhe might make ſome declaration unfavourable to his wiſhes, thought fit to endeavour to prevent it, by ſaying to her, with a profound reſpect, Ah, madam, do not make your miſtaken compaſſion more cruel to me, than the ſeverity of the Romans themſelves, which we Chriſtians juſtly tax, can poſſibly be: for they will but, in a few moments, take away that life, which you would, at once, protract and render miſerable. Do not, I beſeech you, madam, (continues he) think my ſervices meritorious, becauſe they are paid you in this place, and in your perſecuted condition: no, madam, *Theodora* has prerogatives enough to make many leſs unworthy (though not more zealous) than I, ambitious to ſerve her, in what circumſtances ſoever providence ſhall think fit to place her. Whatever the Romans, that worſhip fortune and victory as goddeſſes, and find their proſperity the powerfuleſt argument to ſupport and ſpread their religion, may think of ſufferings embraced for conſcience ſake; ſure we Chriſtians, that adore a crucified Saviour, who, as he *took upon him the form of a ſervant*, was put to death between two thieves, as a ſlave and a malefactor too, ought not to let any perſecutions, or indignities, leſſen our veneration or concern for thoſe that chuſe to ſuffer for him, and imitate as well as own him, whatever it coſt them. Nor, madam, (purſues *Didymus*) needs your having been brought to this place make you think your ſelf at all diſhonoured, in the opinions of thoſe, that can make juſt eſtimates of things: they look on ſufferers for truth with his undecievable eyes, that, by one of the pen-men he inſpired, having mentioned thoſe perſons, that, for religion's ſake, were impriſoned, deſtitute, tormented, affronted, forced in the ſkins of beaſts, to wander like them in deſerts, and lodge in dens, honours them with this character and teſtimony, more glorious than all the panegyricks of orators, and laurels of conquerors, that the world was not worthy of them: and ſuch judges will think Venus an infamous courtezan, though the Romans adore her in their temples; and will not think *Theodora* the leſs excellent perſon, for having been condemned on the ſcore of virtue to a ſcandalous place. Honour were a mean thing, and not worthy to have its loſs much feared, or regretted, if we could forfeit it without having forſaken virtue, and much more, if we could be deprived of it for having cloſely followed her. Nothing can blemiſh true reputation, that cannot be declined without manifeſt injury to religion, which juſtifies our acting whatever it impoſes. The angels themſelves, that were ſent to *Sodom*, ſcrupled leſs to go thither, than to diſobey him, that made it their duty to do ſo, nor were polluted by entering into that abominable place; and being attempted by the brutiſh inhabiters of it, carried thence the angelical purity, wherewith they came thither.

DIDYMUS thought fit to ſay what has been repeated, that he might conſole ſo chaſte a virgin as *Theodora*, who had ſtill enjoyed, as well as merited, a ſpotleſs reputation, by aſſuring her, that the barbarous affront ſhe had been expoſed to, for conſtancy to her religion, had not, among unbyaſſed judges, leſſened the high eſteem her former life had juſtly given them of her virtue: but he would not diſcourſe long of a ſubject ſo nice, that it was difficult not only to inſiſt on it, but ſo much as to mention it, without being uneaſy to ſo tender a modeſty as hers he was ſpeaking to. Upon which account, paſſing on to another argument, he told her, Theſe things I have mentioned, madam, to let you ſee, how little I can pretend to merit by the circumſtances of the duty I pay you; and conſequently, how little you need ſcruple to accept of my further ſervice, without which my paſt endeavours will be uſeleſs to us both: And give me leave to own to you, madam, that it was not without much trouble, as well as ſurprize, that I heard the incomparable *Theodora*'s merit ſo much injured, as to have the valuableneſs of my life put into the balance with that of her's, nay, and made to preponderate. Alas, madam, there are legions, that, as well as I, dare expoſe their lives to the greateſt hazards, and run greater dangers for ſome deſpicable pay, or a few worthleſs leaves, than I do to ſerve my religion, and the faireſt profeſſor of it. Every day affords thouſands of ſuch men as I; elſe the Roman camps would not be ſo frequently recruited, and thoſe numbers, that fall in breaches, or in battles, would not have their rooms ſo ambitiouſly ſupplied by men, that ſee them do ſo. But ſuch perſons as attain to be both the ornaments of their religion and the honour of their ſex, muſt be ſo excellent, and are ſo rare, that it is not every age that produces ſo much as one of them. Such exemplary ladies, do as well improve as enoble the times and places they live in; the reſpect and love men have for them, makes their good counſels very perſuaſive; the lovelineſs of their perſons is ſo diffuſed to their actions, as, by making men forward to take them for examples, adds to their virtues both a great ſplendor and a powerful influence. That *Theodora* is not only one of that ſmall number, but eminent in it, nothing but her preſence, could keep it from being uneaſy for me to evince: but, madam, (continues he) though in ſuch circumſtances, as mine, your ſcrupulous modeſty may keep men ſilent, yet it ought not keep them from being juſt. Your profound humility may draw a curtain, that may hide your virtues from your eyes; but, in the eyes of others, it cannot but increaſe their number, and exceedingly add to their luſtre. You need not therefore, madam, (purſues he) ſcruple to receive the ſervice I aſpire to do you, upon an injurious apprehenſion, that it is above reward, whilſt indeed it pretends not to any at all, except the ſatisfaction and honour, that will be inſeparable from the performance itſelf. Here *Didymus* pauſed for ſome moments, being ſenſible, how difficult a taſk he was entering upon; ſince it was, without prejudicing his love, to own to his miſtreſs herſelf, that he did not ſerve her upon the ſcore of that: but however, the ſincerity of his affection, and the great deſire he had to make his perſuaſions prevalent, haſtened him to prevent her anſwer, by thus proſecuting his diſcourſe; It is true, madam, that *Theodora*'s perfections did not miſs in me, to have the operation, that they are wont to have upon thoſe, that enjoy the opportunities of conſidering them: and if ſhe had been in a diſtreſs greater than that ſhe is now in, though her religion had not at all contributed to bring her into it, I ſhould joyfully have expoſed myſelf to a greater hazard, than I now run, to reſcue her from it. But, madam, that is not our caſe; for that, which now brings me hither, is none of thoſe ſentiments, that, if I were poſſeſſor of a crown, would bring me to lay that and myſelf at your feet, and think myſelf more happy in your acceptance of it, than in all the advantages and prerogatives, that could belong to it: for, madam, the reſolution, that led me hither, was not inſpired by the fair, but by the devout and virtuous *Theodora*. If ſhe had no charms, but thoſe, that cannot be ſeen with bodily eyes, or if her viſible beauty were but moderate, or none at all; her exemplary piety and unſhaken conſtancy, ſhining in ſuch extraordinary expreſſions of them, as ſhe has this day given, would make me think myſelf unworthy of life, if I ſhould ſtick at hazarding it to ſave ſo precious a one as her's, and what I knew ſhe would far more unwillingly loſe; and thereby do ſome right to divine Providence, which, by ſo unexampled a reliance on it, was thought, in ſome ſort, engaged to anſwer ſo uncommon and intire a truſt. After what ſhe did for Chriſt, I did not think I could do enough for her, if I did leſs than I have endeavoured to do; and therefore, madam, (concludes he) I hope as well as beg, that you will no longer ſcruple to accept of that reſcue, that Providence offers you, by an unmercenary and moſt willing hand, but will vouchſafe to make uſe of this military garment, (at which words *Dydimus*, with great reſpect, pointed at his) and allow my endeavours, by procuring your ſafety, to ſecure my happineſs.

To this moving ſpeech, the fair perſon, that it was addreſſed to, returned this calm anſwer:

THOUGH the handſome and obliging things you have been pleaſed to ſay, generous *Dydymus*, have made all the impreſſions on me, that they ought to have; yet I muſt, with your pardon, freely tell you, that they naturally afford an inference, quite oppoſite to what you would conclude from them; ſince, by diſcovering more and more of your gallantry and friendſhip, they let me ſtill further ſee, how much the world would loſe, by being deprived of ſo much virtue, and how unexcuſable I, above all others, ſhould be, if I ſhould be willingly acceſſary to that loſs. Your too too exceſſive compliments I muſt not pretend to anſwer, ſince it would be too great a reflection on your judgment, as well as mine, to think you meant them for any thing more than what I have called them. But in anſwer to the ſerious part of your diſcourſe, I ſhall tell you, that if I had proceeded in what I was going to ſay to you, when you interrupted me, I had, perhaps, prevented ſome of the things you have ſaid, by freely acquainting you (as I now mean to do) with the ſtate of my caſe, and the intentions it ſuggeſted to me. When the inhuman preſident (continues *Theodora*) had condemned me, either to offer ſacrifice in an idol temple, or be led away to this infamous place, I was in ſuch a perplexity and agony, as can hardly be conceived, eſpecially by a perſon that is not of my ſex; for death itſelf was thought too mild an evil, to be one of thoſe, among which I was condemned to make my choice. On the one ſide, the infamy of this deteſtable place was that, which I could not think on, without the utmoſt horror and indignation; and not only my ſex and breeding, but even the dictates of more than one virtue, (modeſty and chaſtity) concurred to heighten my abhorrence of it: but on the other ſide, I remembered, that I did not vow obedience to God with any exceptions or reſerves; that I was both a diſciple and a worſhipper of a perſecuted and affronted Redeemer, for whom (though there were not an infinite inequality between our conditions) I could not ſuffer more, than he had already ſuffered for my ſake; having not only *endured the croſs*, but *deſpiſed the ſhame*, which the *Jews* inſolent malice, and the Romans barbarous cuſtom, had annexed to it. And I thought, that, perhaps, Providence had led me into this diſtreſs, to give me an opportunity of ſhewing, that I could do more than die for Chriſt. But I muſt not now trouble you with the various thoughts, that diſtracted mind on this diſmal occaſion, on which, all that I could ſay to thoſe, that rudely preſſed me to give a poſitive anſwer was, that of the things they propoſed, I plainly ſaw, that both were to be refuſed, and therefore I could make choice of neither. But ſince I would make no election for myſelf, their malice ſoon made one for me, of this deteſtable place. I was ſo confounded, and, as it were, ſtunned, at the firſt ſteps they forced me to take towards it, that I ſcarce knew what to think, or what I did, ſave that I remembered, that idolatry was in the ſacred books repreſented as a moſt odious, though ſpiritual fornication; and that apoſtacy would be my own crime, whereas the conſequences of refuſing it could make me but the object of another's: and remembering myſelf to be a daughter of him, that againſt hope believed in hope, to follow God's call, I did, like him, obey, not knowing whither I went; yet having this ſatisfaction, that I acted according to the dictates of a well informed conſcience; ſo that, whatever the way might prove, I need not fear to be miſled by cloſely following an infallible guide.

HERE the chaſte virgin's words were a little interrupted by the flowing tears, and the inevitable diſcompoſure, that were produced by the ſad remembrance of the diſtreſſed condition ſhe was recounting; but having, as ſoon as ſhe was able, ſuppreſſed thoſe viſible effects of her virtuous grief, ſhe thus purſued her diſcourſe.

REVOLVING theſe and the like thoughts in my mind, I arrived at this infamous place; and being for a while left alone in this room, to try whether yet I could be brought to change my mind; the nearer approach of what I was to endure, making it look more hideous to me, than, till then, I thought it was poſſible for any thing to appear, made me preſently think of flying for refuge to the dark ſanctuary of death, and, by diſpatching myſelf, drown in my yet untainted blood both my own diſmal fears, and my perſecutor's brutiſh hopes. But then there came into my mind, what I had been often taught, and, whilſt I was unconcerned, judged rational to believe, of the unlawfulneſs of killing one's ſelf upon any account whatſoever. I conſidered, that God, who made our love unto ourſelves the ſtandard of the affection we owe our neighbour, in forbidding us to deſtroy another's life, muſt be ſuppoſed much more to prohibit us that violence againſt our own. And if fratricide be juſtly liſted amongſt the blackeſt crimes, becauſe of that relation the ſlaughtered perſons have to thoſe, that kill them; how criminal upon that ſcore muſt be the murder of ourſelves, where the relation is not nearer, only becauſe it is too near to be properly any at all? The ſovereign author and abſolute Lord of our lives having thought fit to employ us here in his ſervice, we cannot, without violating our duty to him, deſert it, until we have performed his errand, which is, to glorify him by our lives, till loyalty to his truth, or his commands, convince us, that we may better glorify him by our deaths. Such conſiderations as theſe would, I hope, have reſtrained me from ending my life with a crime; but the thoughts of it were quickly ſuppreſſed, by my remembering, that in this place I was deſtitute of inſtruments to act it with. Wherefore remembring, that *Daniel* had been preſerved, though not from the lion's den, yet in it; and his three friends were not delivered from the fiery furnace, till they had been caſt into it; and having learned by thoſe examples, that no ſuccours can come too late, that God deſigns for our reſcue, I betook myſelf to prayer, as the moſt hopeful, as well as the moſt innocent courſe, I could take; and with an ardency, heightened with the extremity of my diſtreſs, I was beſeeching God, though with the loſs of my life, to preſerve a purity, that by his grace had been hitherto kept unblemiſhed, when your unexpected entrance brought me a return of thoſe prayers I had yet ſcarce uttered. Judge then, generous *Didymus* (ſubjoins *Theodora*) by the condition I was in, how much I muſt think myſelf obliged by ſo brave and ſeaſonable an attempt to deliver me out of it.

To ſerve ſo bright a virtue, lodged in ſo noble a ſhrine, I thought, madam (ſays *Didymus*, interrupting her) to be as much my duty, as to have found an opportunity to do it is my happineſs: and if you pleaſe to permit me, as I now hope you will, the honour and ſatisfaction of compleating my endeavours to deliver you, I ſhall much more value myſelf upon the having paid you that ſervice (though it be more proportionate to my power, than to my deſires) than if I had reſcued a Roman general, or, for ſucceſsful attempts, been made one myſelf.

WHEN thanks are purchaſed by merit, replies *Theodora*, to diſclaim a right to them, does not forfeit it, but increaſe it; nor need you make me any new profeſſions, ſince after the teſtimonies you have given me already of your virtues, and your friendſhip, I ſhould make myſelf unworthy of them, if I doubted of their reality, or greatneſs. Yes, *Didymus*, I believe what you declared of the diſintereſtedneſs of your proceedings in the reſcue of a perſon of no greater merit, than I can pretend to; ſince the circumſtances of your attempt make it appear too generous to let me ſuſpect, that the aim of it was other than noble too: and indeed, after what you have done (continues ſhe) it would ill become me to ſcruple to be further obliged by you; and therefore I ſhall venture to make you a requeſt, as ſoon as I ſhall have acquainted you with the reaſons it is grounded on.

Didymus being ſurprized at this welcome declaration, was going with tranſports to aſſure her he could deny her nothing, nor obey her in any thing without joy, when ſhe prevented him, by thus continuing her diſcourſe. You know, my generous deliverer, that virgins have ſo great and clear a right to keep themſelves ſuch againſt all outward aſſaults, that monarchs themſelves (whoſe force is not to be by force oppoſed, when it tends but to deprive us of our lives) may be forcibly reſiſted, when they ſtrive to offer violence to our chaſtity. Since, then, an untainted purity is a jewel, that the poſſeſſors are allowed to preſerve and defend, even by uncommon ways, if others will not ſerve, and ſuch as would in other caſes be unwarrantable; though I do not, as I lately told you, think it lawful, as many do, to ſecure virginity by ſelf-murder, yet I cannot diſapprove their opinion, that allow a virgin, in caſe of extremity, to implore that death from another's hand, that ſhe is forbidden to give herſelf with her own; ſince, in ſuch a calamitous condition, heaven, by debarring her all other ways of eſcaping from defilement, ſeems to approve of this. And the ſcripture informs us, that though the prophet *Jonas* held it unlawful to drown himſelf, yet he perſuaded thoſe, that ſailed with him, to caſt *Jonah* i. 12.
him bound into the ſea, when neither they nor he expected he could out-live many minutes (as indeed it was not without a miracle that he did.) Wherefore, purſues *Theodora*, if you will perfect what you have ſo obligingly begun, you muſt lend me your arm and ſword, to free me by a ſpeedy death from miſchiefs much greater than it. The Romans will eaſily believe, that my reſiſtance and provocations tranſported you to a revenge

venge, at which the barbarous uſage I have received at their hands makes it unlikely they will be much offended: the grant of my requeſt will not hinder you from being, what you are pleaſed to think a title, *Theodora*'s deliverer; for in the eſtimation of equitable judges, as well as in hers, it will ſuffice to give you a right to that title, that you have delivered her from her greateſt calamity and danger; nor will the good office I deſire, be inconſiſtent with my obtaining the honour of martyrdom. St. *John* the Baptiſt, becauſe his bold zeal for the laws of religion gave the firſt riſe to thoſe perſecutions, that terminated in his death, is juſtly reckoned among martyrs, though he was privately beheaded in his priſon at the ſolicitation of a Courtezan: and if one willingly ſuffers death for the truth, or the intereſt of religion, there needs not a ſcaffold or a ſtake, and a public executioner, to make ſuch a perſon a martyr. And ſince the perſecutions, that now make havock of the church, are like to continue long; and ſince I am reſolved, by God's aſſiſtance, never to avoid them, by any either unlawful or unhandſome way; the eſcape you would perſuade me to, would but for a while delay thoſe ſufferings I ought not to ſhun, and would make them much leſs acceptable, by my having endeavoured to avoid them; eſpecially by an action ſo mean, if not criminal too, as to conſent to the loſs of an excellent perſon, that moſt generouſly expoſed himſelf for my ſafety. Deny me not therefore, concludes *Theodora*, with tears in her eyes, the laſt requeſt I ſhall ever make you; but by ſheathing your ſword here, (at which words ſhe pointed, with bluſhes, at her fair and innocent breaſt) be pleaſed, by one quick and charitable ſtroke, to perfect my deliverance, without making me ſtain it with the blood of my deliverer: free us both from eminent danger, me of being diſhonoured, and you of being tormented; and by the ſame act of friendſhip ſecure me the coronet of virginity, and procure me the crown of martyrdom.

GREAT was the ſurprize, and greater was the trouble, wherewith *Didymus* heard the concluſion of this diſcourſe: in anſwer to which, as ſoon as his aſtoniſhment would permit him to ſpeak; Ah madam, ſays he, what have you ever ſeen in the unfortunate *Didymus*, that could tempt you to make him ſo ſtrange a propoſition? that I, whoſe errand hither was to venture my life in your ſervice, ſhould myſelf deſtroy the admirable perſon I came to reſcue; and that *Didymus* ſhould imbrue his guilty hands in *Theodora*'s innocent blood, to ſave one drop of which he would gladly ſhed all his own? As your piety deſerves to be the pattern of more than one age, ſo I doubt not, but that in times very remote from ours your memory will ſhine as bright, as your virtue and your eyes do now; and then, how hideous a monſter muſt I appear to poſterity, that will look upon me as one, that could in a trice paſs from pretending to be your deliverer, to be really your murderer; and this for no other reaſon, than that you were pleaſed to manifeſt a great concern for my preſervation? And pardon me, madam, (continues *Didymus*) if I tell you, that your generoſity makes you forget ſome of your other virtues, and even of the dictates of the religion you have hitherto adorned; ſince your commands, if obeyed, would engage me to commit a crime, and make you yourſelf more than acceſſary to it. For, madam, ſince you acknowledge ſelf-murder to be unlawful, how can your commands give me a right to take from you a life, that you have not power to diſpoſe of? And what excuſe can I have, without ſo much as the pretence of acting under authority, to deſtroy an innocent perſon? For, madam, ſince I am to declare, why I preſume to do the thing in the world I would leaſt be put upon, to diſobey *Theodora*; give me leave to tell you, that ſhould I execute what you require, the action would not be excuſable in either of us. For as *Adam* ſinn'd in doing a forbidden thing, though ſhe, that prevailed with him to do it, *was firſt in the tranſgreſſion*, and the Jewiſh prophet was torn in pieces by a lion, though he did what he was ſeduced to by the perſuaſions of a prophet; ſo the ſcripture clearly condemns *David* of murder, becauſe he killed *Uriah*, though not with his own hand, yet with the *ſword of the children of Ammon*: and the ſcripture tells us too, that God plagued the children of *Iſrael* in the wilderneſs, becauſe, as the text expreſſes it, *They made the calf, that Aaron made*. And indeed, by whatever hand innocent blood is ſhed, the guilt of it will light upon the perſon, that procured it to be ſpilt. And to this I muſt add, that ſince Chriſtians are in ſome caſes not only permitted, but exhorted, if not commanded, *To lay down their lives for one another*; the high value and concern I juſtly have for yours, makes me conclude, that this is certainly one of thoſe caſes, and conſequently, that I may lawfully offer you a ſervice, which you perhaps cannot lawfully refuſe: ſince providence has left you no other innocent way, than the acceptance of it, to eſcape your preſent danger. And the guilt of ſelf-murder may, for aught I know, be contracted, not only by a poſitive act, but by an inflexible refuſal of the proffered means of ſafety. Pardon me, I beſeech you, madam, purſues *Didymus*, if the great concern I have for ſuch a perſon as *Theodora*, has extorted from me a greater plainneſs of ſpeech, than my profound reſpect for her would permit me, upon any other occaſion. And becauſe I perceive, that that, which makes you moſt ſcruple to grant my humble requeſt, is, that your ſuperlative generoſity, and what your humility perſuades you to think gratitude, make you ſolicitous for the preſervation of a life hazarded for your ſake; I muſt aſſure you, madam, that your inflexibleneſs will no way make proviſion for my ſafety: for if I ſhould be condemned by your cruel commands

mands to leave you expoſed to the barbarous and defiling rudeneſs of thoſe brutiſh ſatyrs, that impatiently wait without, the regret and ſhame of having miſſed the honour of *Theodora*'s reſcue will give me far greater torments, than the Romans can, for having effected it. And I muſt add on this occaſion, madam, (continues he, not without ſome change of colour and voice) that ſome ſentiments (which though I think not this a fit time or place to name, have been much confirmed and heightned, by what I have this day had opportunity to obſerve) have ſo faſt tied my happineſs to your welfare, that the preſence of my ſoul is ſcarce more neceſſary to my life, than your ſafety is. Nor fancy, madam, that the belief I own of the unlawfulneſs of ſelf-murder, will ſecure my life; for there are other ways to procure death to him, that is weary of life, than his own ſword, or a draught of poiſon; ſince paſſion alone, when raiſed to a competent degree, may do the office of either of thoſe. And ſince joy itſelf, though the moſt pleaſing and friendly of the paſſions, has by its exceſs proved deſtructive of men's lives; why may not grief, and ſhame, and indignation, which are paſſions more violent, and very unfriendly to nature, be able to produce as fatal effects? And to ſhew you, madam, (continues *Didymus*) how much reaſon I have to think, that your condition diſpenſes me from obeying the dictates of your generoſity, let me, —— But before *Didymus* had annexed his reaſons, a noiſe made without gave him a hot alarm, and made him fear the patience of ſome, that waited without, would not laſt very much longer; and therefore addreſſing himſelf to *Theodora*, with a countenance as petitioning as his words, and eyes, in which his courage could ſcarce repreſs the tears; how long, madam, ſays he, will you upon groundleſs ſcruples neglect an opportunity, whoſe omiſſion will be irreparable? And how can you juſtify to God, the ſlighting the means his providence preſents you, of eaſily ſecuring your ſafety? Ah, madam, (then concludes *Didymus*) by one quick and neceſſary reſolve, regain your liberty, preſerve your honour, and ſecure your life. But if nothing, that has relation to yourſelf alone, will move you, be pleaſed to reward the ſervices I have eſſayed to do you, with the implored grant of your own ſafety; and permit me for this once, rather to ſerve you than to obey you. Nor need your generous ſolicitude for me hinder, or retard your reſolution: the world will not blame a ſpotleſs virgin, for doing what is neceſſary to keep herſelf ſuch; nor look upon it as a part of ingratitude, to grant to one, that has done his beſt to ſerve her, a recompence, that he is ſo ambitious of, as to venture his life to obtain it at her hands. In ſhort, madam, (for the time allows me not a long diſcourſe,) if your cruelty will not permit me to prevent your death, grief, and other paſſions, will not allow me to ſurvive it; and then, (ſuppoſing I ſhould fail of making retreat) would it not be a much more happy fate, that the conſtant *Didymus* ſhould die for having ſaved the matchleſs *Theodora*, than for having loſt her?

CHAP. III.

TO theſe pathetic words he thought not fit to ſtay for an anſwer, but retiring to a corner of the room, he diveſted himſelf of his military coat, and upon his knee preſented it to *Theodora*. She, in the mean time, reflecting upon his arguments, was by their force convinced, that the motion ſhe had made him of killing her, was grounded upon a dangerous error. And the noiſe, that had been made, in the outward room, alarming her, at leaſt as much as it had done him, let her ſee ſhe had no further time left her to deliberate. And therefore, being prevailed with, by ſupplications made in ſo perſuaſive a way, that it appeared a far leſs cruelty, even towards him, to accept, than finally to refuſe, his offer; ſhe firſt made her bluſhes and her ſilence intimate her conſent, and then declared it more expreſly, by raiſing him, and taking out of his hand what he preſented to her. And to his joy (which his foreſight, that his ſucceſs would be fatal to him, could not hinder from being very great) ſhe received from him inſtruction how to put it on, and permitted him (though not without ſtrange diſorder in her mind and looks) to aſſiſt her; for as it was abſolutely neceſſary to do it, ſo he did it with all imaginable care, to diſtreſs ſo nice a modeſty, as little as was poſſible; and therefore, as ſoon as ever he had done that, with all the reſpect and decency the place and occaſion would by any means permit, all that could be done without him, he left her to do herſelf, withdrawing to a part of the room, whence he could not ſee her: which retreat he was induced to make, not only out of civility and reſpect, but perchance becauſe the dangers, that threaten internal chaſtity, have this peculiar fate, that uſually thoſe perſons are moſt careful to ſhun them, that are the moſt reſolved and the beſt able to ſurmount them.

As ſoon as the mutual exchange of their habits had made it decent for them to diſcourſe together, the diſguiſed virgin, with cheeks covered with bluſhes, and with looks ſo obliging, that they alone would have recompenced *Didymus* for any leſs ſervice than that ſhe now received, addreſſing herſelf to her benefactor; If your reaſons, ſays ſhe, had not convinced me, that I could not without a crime free myſelf from my wretched condition by death, and if yet death were not the only way, by which, if I decline your generous proffer, I can poſſibly ſhun, what I far more apprehend than death, diſhonour; I ſhould not leave you in a danger, wherein only your concern for religion and for me has engaged you. But I doubt not the ſame charity, that put you upon making me your generous proffer, and preſſing me not to decline it, will make you pardon a fault, to which your own reaſons and importunity have made you highly acceſſary; eſpecially ſince I know you think a tenderneſs of honour, and an abhorrence of all defilement, to be things ſo allowable in a virgin, as very much extenuate, if not juſtify, what they require of her. And indeed I ſhall do you but right, when I thankfully acknowledge, that in this whole tranſaction about my reſcue, your carriage has been ſuch, as would leave me no doubt, if ever I had been ſo unjuſt as to have any, of the purity and diſintereſtedneſs of your intentions, by which I am not a little confirmed in the opinion I have always had, that virtue may inſpire as noble and as hazardous enterprizes, as paſſion can. I know, that in this day's work you aimed at higher retributions, than could be expected from one in my condition; but yet I think myſelf obliged to aſſure you, that your heroic acts of virtue and friendſhip have not been exerciſed towards a perſon inſenſible of them; but that your merit and your favours have produced all the eſteem and other ſentiments, which they ought to produce in a perſon, that is not altogether incapable to diſcern and value them. And if the prayers of a diſconſolate virgin, then ſaved by you, when all the reſt of the world had abandoned her, can have any intereſt at the throne of grace, they will obtain for you bleſſings as great as your generoſity to me has been, and not leſs laſting, than my ſenſe of it will be; and you will, during a long protracted life, either be allowed quietly to enjoy the glory, your many meritorious hazards of it have purchaſed, or elſe be enabled to find a happineſs in your very ſufferings, by virtue of thoſe peculiar conſolations, that are reſerved for a perſecuted condition; as antiently manna was vouchſafed the *Iſraelites*, only whilſt they were exiles in the wilderneſs. The quick ſucceſs God has been pleaſed to grant my prayers for my own deliverance, lets me not deſpair to find him propitious to thoſe I ſhall with no leſs ardency put up for yours: but if your charity ſhould expoſe you to further danger, I ſolemnly promiſe you, that you ſhall find I have been inſtructed, as well as obliged, by your generoſity, and would not have left you expoſed for my ſake, that I might ſhun any danger, that had threatned but my life.

AND now the mournful virgin being to bid her accompliſhed votary a farewel, which probably enough would prove the laſt, by a manifeſt change in her countenance, and the tone of her voice, and by the multitude of tears, that fell from her fair eyes, convinced him no leſs of the trouble ſhe was in upon his account, than any verbal expreſſions could do it; though ſhe ſaid to him, in a moſt obliging manner, Farewel, my generous deliverer; and may that God, who ſees with what reluctancy I conſent to your danger, free you happily from it, and richly recompenſe that noble charity, that led you into it. I hope we ſhall yet ſee one another again upon earth: I am confident we ſhall meet joyfully in heaven, by which I muſt confeſs myſelf very highly favoured, not only in my deliverance, but in the inſtrument of it; ſince God makes me not beholden for my reſcue to any common perſon, but is pleaſed ſo to order it, that I receive the greateſt of earthly benefits from the moſt generous of men.

MADAM, replies the much troubled *Didymus*, your own unequalled perfections, and the operation they have had on me, make me ſo much yours, that your wiſhing me happy does more towards the making me ſo, than your humility will allow you to be aware of. You have too much merit, madam, to let the ſervices I have paid you, have a title to any; and what I have had the happineſs to perform, is but what was every brave man in *Antioch*'s duty to endeavour: but if your goodneſs will needs make you think, that my poor ſervices ſhould have another (for they can ſcarce have a greater) recompence, than you have already given them, by ſuffering them to contribute to your ſafety; and if you will vouchſafe to allow the memory of him, that did them, a room in your thoughts, (which is the happieſt ſtation it can aſpire to upon earth,) I humbly beg your faithful ſervant's image may be looked on without any troubleſome degree of pity; ſince his condition will then need none, and the idea would very much miſrepreſent the original, if it ſhould diſquiet her, whom he never approached but to ſerve her. It is ſuitable, madam, to this frame of mind, that for *Theodora*'s ſake I muſt now deny myſelf ſo much, as to haſten her departure, leſt ſome croſs accident ſhould prevent it: at which words, looking on her with a countenance, that all his courage could not keep from a diſcernible change, Farewel, ſaid he, incomparable *Theodora*; may you continue long the ornament and the pattern of your ſex; and ſince we ſee, that ſome fruits may be as well preſerved in honey, as others in brine and vinegar, may the height of your virtue be kept up, but the objects of it ſo changed, that by a ſettled proſperity you may henceforth have occaſion to exerciſe your moderation and your gratitude, inſtead of your courage and your patience. Once more farewel, concludes he, unequalled *Theodora*; and may you live but with as much contentment, as, if I ſuffer for you, I ſhall die with ſatisfaction.

THOUGH theſe moving expreſſions, and the accent, wherewith they were delivered, did very ſenſibly touch a perſon ſo well natured and grateful as *Theodora*; yet ſhe thought the fitteſt return ſhe could then make to her lover's diſcourſe, was preſently to follow the advice he was ſo earneſt to have her ſpeedily embrace: and therefore bidding him farewel, only by a look, wherein high degrees of ſorrow and gratitude were plainly mingled, ſhe immediately diſpoſed herſelf to quit that diſmal place; which then afforded a noble inſtance, how little a great mind can be hindered from diſcloſing itſelf to be ſo, by the ſtage it is obliged to act upon: for whilſt in divers of the ſtately temples of *Antioch*, whores, (ſuch as Venus and Flora) and raviſhers and adulterers, (ſuch as Jupiter and Mars) were ſolemnly adored in an infamous ſcene, dedicated to public luſt and violence, the ſtricteſt chaſtity was exerciſed, and martyrdom itſelf was contended for.

Having once ventured into the outward room, that providence, to which ſhe had, in ſuch diſcouraging circumſtances, truſted her virgin purity, would not leave the reſcue of it incomplete; but whilſt the waiting ruffians were eagerly contending, who ſhould ſucceed the perſon they took, by the habit, to be *Didymus*, (and whoſe face they did not wonder to ſee muffled, preſently after ſo ſavage an action, as they ſuppoſed him to have committed) brought her ſafely out of that infamous place: whence, by the leaſt frequented paſſages ſhe knew, ſhe was quickly conveyed to the houſe of her dear friend *Irene*, which happened to be nearer than her own.

There, to avoid ſuſpicion, ſome of her friends and relations were met together, to lament her captivity, and join in prayer to him, that alone could deliver her, to be directed by God, how they might (if it were poſſible) contribute to her reſcue. But though their prayers were probably made with more zeal than hope, they were not a little alarmed, when looking out to ſee, who knocked at the door, they ſaw, as they thought, a ſoldier, who would not have been quickly let in, if *Irene* had not preſumed it to be *Didymus*, who was coming to offer his ſervice to his captivated miſtreſs. But it is not eaſy to expreſs the wonder and the joy, with which they ſoon diſcovered that this was not *Theodora*'s lover, but herſelf, whoſe beauty, and her military dreſs, would have made her, had the Roman guards diſcovered her, paſs for their Pallas: nor was ſuch a habit, though improper for a virgin, unſuitable to a great, as well as chaſte conqueror.

But though her preſence never needed the endearment of a ſurpriſe, yet the unexpectedneſs of it at that time and place, added to the tranſports it produced, eſpecially in *Irene*, who, after a thouſand gratulations and careſſes, at length begged, in the name of the impatient company, to know, how the bleſſing they all received in her freedom, was procured. To which reaſonable requeſt ſhe anſwered, by making a ſhort but faithful narrative of what had occured, ſince the time ſhe was cited before the preſident, till ſhe came to take ſanctuary among them; piouſly concluding, that, as what ſhe had done not miſbecoming a Chriſtian was altogether by the aſſiſtance of divine grace, ſo the ſuccour ſhe received to bring her out of danger, was by the conduct of divine Providence, which in her delivery made uſe of the high virtue and generoſity of *Didymus*. This relation made the company firſt return thanks and praiſes to the divine Goodneſs, which were followed by the celebrations of the happy inſtrument of it; every one, as it were, by turns, endeavouring to vye, who ſhould moſt commend ſo venturous and diſintereſted a lover: nor perhaps did *Theodora* herſelf, inwardly diſſent from that grateful company; for though her modeſty and reſervedneſs kept her from declaring her ſentiments, as others did theirs, yet, perhaps, that was becauſe ſhe thought, that having given a candid account of his deportment, her narrative had made praiſes needleſs, the hiſtory itſelf being indeed a panegyric.

After the company's curioſity was ſomewhat ſatisfied by what *Theodora* had told them, and both *Irene* and ſhe had made a requeſt to a gentleman, that knew *Dydimus* well, to endeavour to bring them ſpeedy notice of what had happened to him, or was like to befall him; the two excellent ladies retired to the apartment of *Irene*. There the pious *Theodora*, having devoutly paid her ſolemn thanks and praiſe, for her almoſt miraculous deliverance, to the divine Author of it, ſhe was accommodated by her friend, with clothes befitting her ſex: nor was it difficult for *Irene*, (though on ſo ſudden an occaſion) to furniſh her with a habit ſhe liked; for beſides that a perſon ſo ſhaped and faſhioned as *Theodora* could make almoſt any dreſs graceful, ſhe uſed to pity the mean vanity of thoſe ladies, that could be either ambitious or proud of what they muſt owe to a taylor or a dreſſer, and affected to be taken notice of, not ſo much for what they are, as for what they wear; and therefore, though ſhe did not ſcrupulouſly decline faſhionable clothes, becauſe they were ſo, yet all the ornaments, that paſſed the limits of the modeſteſt decency, ſhe always as little valued, as ſhe needed them.

CHAP. IV.

BEFORE this rare couple returned to the reſt of the company, *Irene*'s kindneſs for *Didymus* made her think ſhe ought not to loſe this opportunity, of doing good offices to her abſent friend: and therefore having (as ſhe eaſily might) brought the diſcourſe to fall upon his late performances; I hope, madam, ſays ſhe to *Theodora*, you are now ſatisfied, that the character I gave you of the greatneſs of my couſin's virtue, and the ardency of his flame, was dictated more by his merit than my friendſhip. I were very ungrateful, replies *Theodora*, if I did not willingly acknowledge his generoſity to be altogether extraordinary, and that, as he could not oblige me more highly than he has done, ſo it was not poſſible, that he ſhould do it more handſomely.

I know, madam, ſaith *Irene*, that *Theodora* may freely chuſe among all the illuſtrious youth of *Antioch*, what perſon ſhe would pleaſe to make happy: and, without conſidering her leſs obvious, though more admirable perfections, far leſs beauty than ſhe is miſtreſs of has, in our times, given the poſſeſſors a ſhare in the imperial throne, and perhaps too placed them upon the Roman altars. But yet, continues ſhe, ſince I have the honour to know you too well, not to be confident, that you value piety and virtue, and a flame regulated and excited by them, above thoſe outward advantages, which weaker ſpirits are influenced by; I think I may preſume to ſay, that I know not any perſon in *Antioch*, to whom the fair *Theodora* may, with leſs condeſcenſion, vouchſafe a ſhare in her favour, than to him, that had the happineſs to give her ſo clear a proof of the ardency, the purity, and the diſintereſtedneſs of his flame.

IF I had not, replies *Theodora*, with a ſomewhat diſſatisfied look, been much ſurpriſed at the beginning of your diſcourſe, I had immediately ſtopped you there, and lamented my infelicity, that *Irene*, whom I thought myſelf happy in having for my friend, allows herſelf, what is ſo repugnant to true friendſhip, as flattery is. I could, continues *Theodora*, without pauſing, for fear of being prevented, eaſily, and with the approbation of many of the beſt judges in *Antioch*, return the fair *Irene* her own compliments, if I thought fit to imitate what I cannot approve: and to ſpeak ſeriouſly, continues ſhe, neither you nor I, nor any of our ſex, ought to think ſkin-deep beauty as great a bleſſing, as it is an applauded one; for, without our fault, and in ſpight of our care to preſerve it, a thouſand accidents may, and time certainly will, ruin the lovelieſt faces, and perhaps to that degree, as not in the remains to leave it credible, that ever they were handſome. It is true, that thoſe vain men, whoſe paſſion maſters their reaſon, are wont (for the moſt part with deſigns we ought not to be proud of) to ſpeak extravagant things, and too often even prophane ones, of the beauties they profeſs to adore: but though they really meant (which they very ſeldom do) all they ſay, in praiſe of thoſe they repreſent as goddeſſes, yet I think a conſidering perſon will ſcarce be very proud of receiving that title from thoſe, who can think, that a few colours and features luckily mingled are ſufficient to make a deity. An uncommon degree of beauty, adds ſhe, expoſes the owner to extraordinary troubles, from the envy of thoſe, that want it, and the importunities of thoſe, that court it. And, without as much caution and watchfulneſs, as turn it into a trouble, it too often proves a ſtrong temptation to thoſe, that admire it, and a dangerous ſnare to thoſe, that poſſeſs it. And if I had the vanity to think, what you would perſuade me to believe, I ſhould yet take beauty in a woman to be like a rich perfume, which, though it be a thing very grateful in moſt companies, and perhaps (eſpecially at firſt) very delightful to the wearer, yet does often diſcompoſe, not only ſtrangers ſhe chances to converſe with, but the beſt friend ſhe has; and not ſeldom does miſchief even to herſelf, by diſordering her head, or caſting her into fits of the mother. I beg your pardon, dear madam, ſays the fair *Irene*, with ſomewhat of ſadneſs in her looks, that whilſt I had ſo much beauty in my eye and thoughts, I forgot, that it was in *Theodora*, accompanied with a far greater and ſcrupulous humility; and I did not apprehend, that I could be thought guilty of flattery, ſo near to a witneſs (at which words ſhe pointed to a looking-glaſs, that hung up in the room) ready to juſtify more than I had occaſion to ſay. I willingly acknowledge with you, that the amiableneſs diſcoverable by the eyes of every gazer is a thing far leſs deſirable than deſired, and procures the poſſeſſors more praiſe, than it brings them happineſs: and for my part, adds ſhe, if I had the weakneſs to believe myſelf miſtreſs of what the folly of ſome has made them flatter me with, yet I ſhould not be over-much pleaſed with a quality, that would add to thoſe harms, my frailty makes me guilty of, thoſe, which I never intended; and makes ladies ſo miſchievous to thoſe that love them, that, even when they do not rob men of their innocency, they deprive them of their quiet. I confeſs therefore, madam, (continues *Irene*) that it was injurious to inſiſt upon the praiſes of a face, when, how little ſoever it can be matched in its own kind, it is accompanied with ſeveral beauties of a much nobler kind: but that, which induced me to ſpeak as I did, was to let the fair *Theodora* ſee, that I was juſtly ſenſible, how great a thing I begged for my friend, when I implored for him an intereſt in her favour. And I do the leſs deſpair of the effects of your goodneſs, both to him and me, becauſe I beg them for an abſent friend, who is not in a condition to ſpeak for himſelf; and who, as I perceived by the obliging relation you were pleaſed to make of his carriage towards you, declined making you any requeſt, when his ſervices were ſo happy as not to be uſeleſs to you. His ſilence, anſwers *Theodora*, in ſuch circumſtances, had more effect on me, than his paſſionateſt ſolicitations would have produced: but the thing, I preſume, you aim at for him, is of that moment to me, that I cannot think fit to diſcourſe of it, till we can do ſo with more calmneſs and leiſure, than we can at this time expect. You know, *Irene*, that I have ſtill looked upon marriage, as one of the moſt important actions of life: and though I think they have too mean a notion of happineſs and miſery, who imagine, that one creature can make either of them the portion of another; yet I think, that not only the dictates of diſcretion, but thoſe of ſincerity and chaſtity, oblige a woman to have a great care, not to enter into ſo near and indiſſoluble a relation, upon any grounds, that are not like to laſt as long as it, (and conſequently, as our lives:) and therefore, a woman, that reſolves to be what ſhe ſhould be, when a wife, ought to deliberate much upon a choice ſhe can probably make but once; and not needleſly venture to embark herſelf on a ſea ſo infamous for frequent ſhipwracks, only becauſe ſhe is offered a fine ſhip to make the long voyage with. But, continues the baſhful virgin, (not without ſome little diſorder in her looks) ſince my dear *Irene* will needs make uſe of the privilege ſhe has to know more of my thoughts, than I would diſcloſe to any other perſon in the world; our friendſhip prevails with me to tell her, that if I were altogether at my own diſpoſal, and could be induced to admit ſuch a change of condition, as I have always been averſe from, I ſhould be more influenced in my choice by the ſhining virtues and extraordinary ſervices of *Didymus*, than by all the advantages, that either titles, or riches, or dignities, could give any of his rivals. But, my dear *Irene*, (adds ſhe) we live in ſuch times, and I, for my own particular, am beſet with ſuch circumſtances, that it were not only very unreaſonable, but wildly extravagant, for me to increaſe my commerce with the world.

FOR, *Irene*, continues ſhe, in my opinion, a Chriſtian does not deſerve to be happy, and a true one cannot think he is happy, whilſt the church of Chriſt is miſerable, at leaſt as far as outward calamities can make it. When I ſee the Empire over-run with idolaters and perſecutors; when I ſee raviſhers and whores adored in ſtately temples, and the only worſhippers of the true God driven into corners, and purſued even thither; when I ſee ſuch, as God is pleaſed to declare *the world not to be worthy of*, treated by men, as perſons not worthy to live in the world, but daily expelled out of it, with ignominy and torments: when, I ſay, (adds *Theodora*, with tears in her eyes,) I conſider the general deſolation of the church, and that I am like and willing to be, not a meer ſpectator, but a ſuffering actor, in this tragedy; I cannot, in the midſt of her ſighs and groans, liſten to the unſeaſonable compliments of a lover, or think of reliſhing any contentment, that deſcends not from a place too high for perſecution to reach. In theſe ſentiments, ſubjoins ſhe, I am warranted by no leſs authority, than that of an apoſtle, who, though not unfavourable to the marriage ſtate, diſadviſes thoſe women, that are free, from entering into it, at leaſt during the preſent diſtreſs, though that were in his time very much inferior to thoſe ſtreights we are now reduced to. Yet, madam, ſays *Irene*, thoſe expreſſions of friendſhip, that a conjugal relation invites, are not only made allowable by it, but commendable; and are as real duties of piety and virtue, as divers of the more abſtracted exerciſes of religion. I do not contradict that, replies *Theodora*, but look upon that very thing, as a diſſuaſive from the ſtate of life you would recommend; for if I could think fit to enter into it, it ſhould be with a reſolution to do all, that becomes me in it: and in ſuch a calamitous time as we live in, I could not do that, without coming far more, than I now am, within the world's reach; ſince I ſhould think it my duty, and perhaps be engaged upon another account, to have ſuch apprehenſions for a near friend's danger, as my own would be uncapable of giving me. And the contentment I now enjoy in a diſpoſition to quit the world without regret, would be deſtroyed, or at leaſt allayed, by an uneaſineſs to part with, what duty and inclination would, perhaps, too much faſten me to. Here *Irene* was going to interrupt her by an anſwer, when her fair friend prevented her, by thus continuing her diſcourſe; And to me it ſeems very conſiderable, that the apoſtle I lately mentioned, clearly enough intimates, that to perſevere in a virgin ſtate, in times of perſecution, gives thoſe, that prefer it, the great advantage of ſerving God more undiſtractedly; and conſequently of being more entirely and uninterruptedly employed in the direct contemplation and ſervices of an object ſo ſublime, that our mind cannot divert to another without ſtooping to an inferior one. And though it be true, that the duties of a relation may rightfully challenge a part of an engaged perſon's time and care; yet I ſee not, why one, that has no need, ſhould enter into a relation, that would make thoſe diſtracting duties neceſſary.

Heb. zi. 38.

THOUGH *Irene* found it ſcarce poſſible to anſwer *Theodora*'s reaſons, yet her kindneſs to her abſent friend made her unwilling to loſe the opportunity their privacy gave her, to make one attempt more in his favour; which ſhe did, by ſaying to his excellent miſtreſs; But ſhall not the as faithful as unhappy *Didymus*, be allowed to hope, that if once thoſe diſmal clouds, that pour down ſhowers of blood, ſhall be happily blown over, he may have a particular ſhare in the publick joy and tranquillity? that his ſufferings ſhall end with the perſecutions of the church? that thoſe fatal reſolutions, that are ſo deſtructive to his happineſs, may ceaſe with their occaſion? that *Theodora*'s ſeverity will not out live the *Roman* cruelty? and that her heart will not be the laſt place, where the Emperor's cruel edicts will continue to have a fatal operation.

ALAS! *Irene*, ſays *Theodora* ſomewhat troubled to be ſo preſſed, how unſeaſonably do you now diſcourſe to me, about things relating to a time, to which very probably my life will never reach! for, ſubjoins ſhe, to deal clearly with you, I am ſo far from flattering myſelf with an expectation of thoſe halcyon days I wiſh you may live to ſee, that I ſhall not be ſurprized, if this day proves the laſt I ſhall ſpend in this world; and if before night I paſs thence into another, where the frailty and mortality, upon which marriage was founded, ceaſing, that condition of life will have no place; but will be ſucceeded by an angelical ſtate, where our friendſhips, as well as our perſons, will be transfigured, and made incomparably more perfect, than they can be here below.

CHAP. V.

THEODORA had ſcarce made an end of ſaying this, when her converſation with her fair friend was interrupted by the notice, that was given them, of the arrival of a gentleman of their religion, who brought ſome news, that it concerned them to know. This advertiſement ſoon brought back theſe two excellent ladies to the reſt of the company, to which this intelligent and inquiſitive perſon was going to give an account, which the ſadneſs of his looks prepared them to find an unwelcome one. However, they liſtened to him with great attention, as well as concern; and he, after a ſhort preamble, briefly acquainted them with ſome particulars, that will hereafter be more fully related. But that, which he himſelf ſeemed moſt moved at the mention of, and which moſt affected his hearers, was this; that when the preſident had notice of *Theodora*'s eſcape, though there wanted not ſome generous men, that endeavoured by ſeveral arguments to diſſuade him from proſecuting her any further; yet he was ſo far from being prevailed with to comply with ſo reaſonable a motion, that he ſolemnly proteſted, that if ever he could get this fugitive (as he was pleaſed to call that admirable perſon) once more into his power, he would never ſtrive again to reclaim her by the fear of infamy, (a thing, which, ſaid he, I perceived ſhe deſpiſed) but by the terror of death; ſuppoſing, as he added, that ſhe would not fly from an altar to a ſcaffold, or a ſtake; and reſolving, in caſe ſhe were inflexible, to ſacrifice her to the indignation of thoſe incenſed deitiess ſhe had ſo obſtinately provoked.

The former part of this diſcourſe, which related to *Didymus*, his excellent miſtreſs heard not without ſuch inward commotions, that, in ſpight of the calmneſs and reſervedneſs of her temper, they clearly enough diſcloſed themſelves in her face, by ſeveral changes of colour, which thoſe, that had lately admired the greatneſs of her courage, could not but aſcribe to that of her concern for her diſtreſſed lover. But when the relator had concluded that part of his narrative, that directly regarded herſelf, though it filled all the auditors with grief and terror, *Theodora* ſeemed to have gained a new life; ſince, in her looks, the viſible tokens of a deep ſadneſs were ſucceeded by no leſs manifeſt ſigns of joy.

While the reſt of thoſe, to whom the melancholy account was given, were entertaining one another with the reflections they made upon it, *Irene* having drawn her fair friend aſide, was impatient to learn the cauſe of that pleaſing change ſhe had obſerved in her looks.

Whilst, anſwers *Theodora*, I was liſtening to the report of the eminent danger, which the generous *Didymus* was expoſed to for my ſake, I could not but be extreamly troubled to find myſelf reſtrained from attempting his reſcue, by the manifeſt danger of being by the barbarous preſident ſent back to the infamous place, whence your virtuous friend had ventured ſo much to free me: but now that the judge, by a ſolemn declaration, has tied up his own hands from tempting me by ſo juſtifiable a fear, as that of infamy; it was no wonder my looks diſcloſed ſome tokens of a joy, grounded upon ſo welcome an opportunity to exerciſe my gratitude without hazarding my honour.

What? *Theodora!* ſaith *Irene*, as it were thunder-ſtruck with this unexpected anſwer, do you put ſo ſmall a value upon that wonderful deliverance, that ſcarce an hour ago you did ſo devoutly and deſervedly give thanks for, that you will ſo ſoon ruſh into greater dangers than thoſe, that required little leſs than a miracle to reſcue you from them?

I hope, replies calmly *Theodora*, that I ſhall never forget, nor without a deep ſenſe remember, the admirable reſcue you ſpeak of. But I take the moſt gracious part of that deliverance to conſiſt in my being reſcued from diſhonour; and think it would be much leſs obliging than it is, if it debarred me from the ſureſt and directeſt ways to glory, and if, to preſerve my external purity, it did condemn me to ingratitude towards the meritorious inſtrument of that preſervation.

Our lives, ſaith *Irene*, being truſted to us, as well as vouchſafed us, by God, are not ſo much at our own diſpoſal, that it is allowable for us to part with them as we think fit; and it is poſſible for us to abandon them, not only when we do directly and violently rid ourſelves of them, but when we do thoſe things, whoſe natural conſequence is an untimely death.

I believe with you, ſaith *Theodora*, that our lives are to be reckoned among thoſe goods, that we are entruſted with, rather as ſtewards than unaccountable proprietors; and acknowledge too, that certain actions, that do not directly, may yet criminally tend to their deſtruction. But I do not think the care of our lives is committed to us, as that of our ſouls is, with ſo indiſpenſable an obligation to keep them, that it can never, upon any terms whatſoever, be lawful for us to loſe them: for I think life to be a talent, which is indeed to be carefully huſbanded and preſerved; but is committed to us, not ſo much to keep ſafe, as to negotiate with; and is entruſted to us in order to a condition better than itſelf. And therefore, if religion, or virtue, require any thing at our hands, which cannot be performed without endangering, or even loſing our lives; in that caſe to venture them, or to part with them, is a duty, and conſequently at leaſt a juſtifiable action: and this, purſues *Theodora*, I take to be my caſe, who am ſummoned by faithfulneſs to a juſt promiſe, and by gratitude to an extraordinary benefactor, to endeavour the ſaving of an innocent perſon, who is accuſed on my account, and has brought himſelf into a great danger, only for having moſt obligingly reſcued me from a greater.

But what, replies *Irene*, if the attempt you deſign is far more likely to deſtroy you, than to ſave *Didymus?* For the barbarous judge is ſo much an enemy to all Chriſtians, as ſuch, and ſo much incenſed againſt you, for your eſcape, and him for having been the author it; that the cruelty of that inexorable man will make him gladly deſtroy you both, as far as human power and rage can do it; and ſo, without preſerving to the church of *Antioch* one of its ornaments, you will deprive it of another, and a greater, by denying it the influence it might receive by ſo laſting and exemplary a virtue, as may juſtly be expected in a perſon ſo pious, and ſo young, as *Theodora*.

The experience, anſwers *Theodora*, that this very day has afforded me, forbids me to diſtruſt divine providence, and keeps me from deſpairing to find my endeavours to reſcue your kinſman ſucceſsful; if the moſt wiſe and good, as well as abſolute diſpoſer, of events, ſhall not think it leſs our advantage to be reprieved, than crowned. Without preſuming therefore to foreſee events, it is my part to do what God has vouchſafed to put into my power; and it is not my duty to reſcue *Didymus*, but it is to attempt it, and thereby acquit myſelf, as far as I am able, of what I owe to my promiſe and my gratitude. If I had the vanity to think, adds ſhe, that in a perſon of my ſex and frailties, ſuch a church as that of *Antioch* could be much concerned, I ſhould think too, that the attempt I am about to make, were the beſt way to make my life ſomewhat ſignificant: for, whereas our heathen adverſaries are ſo blinded with prejudices, that they look upon all we do or ſuffer for Chriſtianity, as the effects of a kind of ſuperſtitious frenzy, that ſeizes us, and tranſports us, whenever the articles of our faith are contended for; my expoſing myſelf to their fury, rather than be wanting to the dictates of gratitude, which they, as well as we, look on as a moral virtue, may help to convince them, that our love to virtue is general, and more diſintereſted, than they thought it; ſince Chriſtians can venture and part with their lives, as well to ſhun ingratitude, as to reſiſt idolatry.

This gratitude, (replies *Irene*) whoſe exceſs gives you and us ſo much trouble, is a relative thing; and benefits or ſervices received ought to be requited by actions, that are acceptable to thoſe they are deſigned to gratify; but ſure not by ſuch, as we know will be unwelcome to them. And therefore, (continues ſhe) the faithfuleſt and moſt diſintereſted of your ſervants will be far more unhappy, than the *Roman* cruelty can make him, if what he has done doth not convince you, that he can never look upon any thing, as a favour or retribution to him, that ſhall deſtroy, or ſo much as endanger his adored miſtreſs.

I were very unworthy, (rejoins *Theodora*) if I did not think *Didymus* capable of the higheſt ſentiments, that generoſity and friendſhip can inſpire. But he is too juſt to forbid thoſe he loves to aſpire to ſome ſhare of thoſe noble qualities, upon whoſe account, I am to conſider, not ſo much what his virtue will reliſh, as what his condition requires; there being a ſort of debts, to which mine to him belong, that ought to be the more carefully paid, the more frankly they are remitted.

The ſorrowful *Irene* being exceeding troubled to ſee her endeavours unſucceſsful on an occaſion, upon which, of all others, ſhe moſt wiſhed to find them prevalent, was prompted by her grief to bring her eyes to the aſſiſtance of her tongue; and weeping, ſaid to her inflexible miſtreſs, If, madam, you will not have any compaſſion for the excellent *Theodora*, at leaſt take ſome pity upon the diſconſolate *Irene*; and if her arguments cannot move you, be not at leaſt inexorable to her fears. You have, (continues ſhe) vouchſafed me the honour of your friendſhip, and the happineſs of your converſation; and by both theſe bleſſings have given me ſo much eſteem and kindneſs for ſo great a benefactor, that if you deny me, what I now implore, you will turn the nobleſt parts of my happineſs upon earth into inſtruments of my infelicity; ſince, in a world deprived of *Theodora*, the deſolate *Irene* will languiſh, rather than live, if ſhe ſhould be able to ſurvive ſo a great a loſs.

Theodora, whoſe reſolution and good nature were both of them extraordinary, though ſhe had courage enough to ſupport calmly her own perſonal ſufferings, yet ſhe had tenderneſs enough to be very ſenſible of thoſe of her friends. And the moving expreſſions of the ſorrowful *Irene*, together with the tears, that accompanied them, made ſuch an impreſſion on her, that though, having foreſeen this ſtorm, it did not ſurprize her, yet it did much diſtreſs her, and let her ſee, how many uneaſy victories ſhe was to gain, before ſhe could triumphantly compleat that day's work. And though after a ſhort, but ſharp, conflict, between her kindneſs and her reſolution, the latter of them prevailed, yet it was not without ſome reluctancy and commotion, that ſhe was able to return this anſwer. Ah, dear *Irene*, do not exerciſe ſo much cruelty yourſelf, whilſt you reproach me for being cruel; and do not add to the great affliction of parting with ſuch a friend as *Irene*, that of ſeeing her ſo much troubled on my account, and of ſeeing myſelf neceſſitated to the uneaſy taſk of denying a requeſt of hers. If what I owe to my religion, and to your generous couſin, would ſuffer me, upon any terms, to alter the reſolution it prompted me to; the declaration of your deſire to have me do it would have made all the arguments, you employed to perſuade me to it, unneceſſary. It is true, that among virtuous friends kindneſs may challenge much, but not to the prejudice of conſcience and reputation. I hope our friendſhip is not, and am ſure it ought not to be, barely a mutual fondneſs of two young virgins;

gins; but that virtue had a greater ſhare in making and continuing it, than ſympathy and inclination had: and it is but juſt, that a friendſhip, grounded chiefly upon virtue, ſhould be governed and regulated by it. Permit me therefore (purſues ſhe) with that freedom and plainneſs, that our friendſhip allows, to put you in mind, that in the ſtreights, wherein providence has now placed us, it calls upon us to conſider, not only that we are friends, but that we are Chriſtians too; who ought in reaſon, as well for our departing as our departed friends, to liſten 1 Theſs. iv. 13. to the apoſtle of the *Gentiles*, who forbids us, upon the removal of thoſe we love, to give *up ourſelves to ſorrow, as thoſe that have no hope.* Indeed, if we were *Epicureans*, that believe the ſoul as mortal as the body, or ſuch other pagans, as bury in the graves of their friends the hopes, or at leaſt the confidence, of meeting them again; we could ſcarce too bitterly deplore a ſeparation, that would certainly, or at leaſt for aught we know, prove an eternal one. But having, through the goodneſs of God, been embracers of the goſpel, and enabled, though but imperfectly, yet ſincerely, to live according to its dictates, and be ready to die for its defence; the ſame grace may keep us from fearing, that the time of our ſeparation will be laſting enough, to bear any conſiderable proportion to that eternity, which will be allowed us to enjoy each others company in. And give me leave to tell you, *Irene*, that I cannot rejoice at any expreſſions, even of your kindneſs, that are injurious to your piety, and bring your love of me into a competition with that, which ought to be as unparalleled as its object is. They love a creature too much, that think it too good to be parted with for the creator's ſervice. It is a high injury to him, to think we can loſe any thing for him, that he cannot make us a rich amends for. And I muſt not conceal my opinion, that a Chriſtian diſparages both himſelf and his profeſſion, if he complains, that any loſs can make him unhappy, while he poſſeſſes the favour of God. Wherefore, my deareſt *Irene*, (concludes ſhe) let your friendſhip alleviate my grief, by ſhewing me, how handſomely you bear your own; and prefer, I beſeech you, upon this ſad occaſion, the exerciſe of the more generous, to that of the more tender, effects of kindneſs.

ALAS! madam, ſays the diſtreſſed *Irene*, all the fine things you ſay to comfort me, produce in me an effect quite contrary to that you deſign by them; ſince they do but the more diſcover the excellency and kindneſs of the incomparable perſon I am going to be deprived of; after whoſe company I ſhall find that of the reſt of the world too inſipid, ſo much as to divert me: and therefore, if you will not grant me the bleſſing of living with you, at leaſt do not deny me the ſatisfaction of dying with you. For though martyrdom be very formidable to a frail woman, yet heaven is more deſirable to a Chriſtian; and I ſhall not fear to take a ſcaffold or a ſtake in my way, when I travel to ſuch a place, as that, in ſuch company as yours.

YOU know, (replies *Theodora*) as well I, that our religion commands us to ſuffer martyrdom, when we are obliged to do it; but forbids us to thruſt ourſelves unneceſſarily upon ſo fatal and difficult a work. The apoſtles themſelves, whoſe peculiar office it was to be the heralds and champions of the goſpel, were commanded, when they were perſecuted in one city, to fly into another; and accordingly one of the moſt courageous of them, to avoid needleſs and unſeaſonable dangers, fled to *Jeruſalem* from *Damaſcus*, Act. xix. 25. though, to do ſo, he was fain to be let down from the wall of this place in a baſket. And it is but reaſonable we ſhould not, without a manifeſt call of providence, venture upon a conflict, in which we do ſo much depend upon extraordinary aſſiſtances for the victory, that the ſame bold diſciple, that ſo confidently promiſed our Saviour, that he would die for him, was, in an hour or two, the firſt, that renounced him. An inſpired teacher, who was ambitious to be, as he afterwards proved, a martyr, reckons it to be the gift of God, not only to believe in Chriſt, but to ſuffer for that belief. If (continues ſhe) our conditions were exchanged, and *Irene*, inſtead of me, were by divine providence ſingled out for martyrdom; I ſhould not envy her the glory, of letting many of both religions ſee, that Chriſtianity can elevate the courage of a woman to a degree, that they think appropriated to men. I would employ my prayers rather to obtain of heaven a divine ſupport of her reſolution, than an inglorious change of it; and imitating that well-natured *Iſraelite*, who not only willingly, but gladly, parted with his dear *Eſther*, when ſhe went from him to a throne, I ſhould be more ſatisfied with *Irene*'s advancement, than with her company; and if I did not prefer her happineſs to my own, it would be, becauſe indeed I ſhould look upon them ſo united, that I ſhould find mine in hers. Let me then (ſays *Theodora*) conjure you by all our paſt and future friendſhip, rather to congratulate, than lament, the remove I am going to make; and be not troubled, that one, whom you have been pleaſed ſo much to love, is called to be early happy. In ſuch hazardous times as theſe, you know not how ſoon the perſecutor's ſword may ſend you after her; and, at moſt, this mortal life is too ſhort, to let our ſeparation be very long. And in the mean time, the comfortable expectation of an unchangeable ſtate, of whoſe bleſſedneſs the renewed fruition of each other, will make a part, and not the greateſt neither, may conſole you for the abſence of a perſon, that in the *interim* will be happy enough to wiſh you where ſhe is, upon much juſter grounds, than you can wiſh her where ſhe was. Let it then (concludes *Theodora*, with weeping eyes,) be a ſufficient proof of my eſteem and

love of *Irene*, that I part from her with tears,
when I am going to a place, where the di-
vine oracles aſſure us, that *all tears ſhall be*
Rev. vii. 17. *wiped from our eyes*, and be ſucceeded by a
Pſal. xvi. 11. *fulneſs of joy*, that ſhall laſt for evermore.

CHAP. VI.

THOUGH theſe reaſonings were ſuch, as *Irene* knew not well how to anſwer, yet being uncapable of acquieſcing in any diſcourſe, that inferred it to be her duty to part with *Theodora*; ſhe reſolved to try, whether the perſuaſions of the company, (which ſhe knew would be very forward to aſſiſt her) would not be more prevalent, than hers had been: and that ſeemed an accident very friendly to her deſign, that juſt then happened, by the arrival of an intelligent gentleman, whom ſhe had a while before employed to learn news of her friend; and who, on that ſcore, had been a curious and heedful ſpectator of all, that had paſſed at the preſident's, in relation to *Didymus*, and was come to bring *Irene* an account of it. To hear this, ſhe and her ſorrowful friend were deſired to rejoin the reſt of the company; to which the high and juſt eſteem they all had of ſo brave a gentleman, as *Didymus*, gave an impatient deſire to be informed of his adventures. To ſatiſfy this curioſity, the gentleman, that was to do it, did, after a ſhort pauſe, make them the following narrative.

I SUPPOSE this company needs not be informed by me of what happened to the Generous *Didymus*, between the time, that the excellent *Theodora* was condemned to an infamous place, and that, wherein he had the happineſs of helping her to make an eſcape out of it: and therefore without waſting any of that little time, whereof, I fear, we may have but too great need, I ſhall proceed to inform you, that when this aſtoniſhment, occaſioned by this ſurprize of finding a young man in the eſcaped virgin's room, was a little over, and they had cloathed *Didymus* in a habit more decent to appear in before a publick aſſembly; they led him away to the judge, to whom ſome of them related, maliciouſly enough, what had paſſed, earneſtly begging juſtice of him againſt a perſon, who (they ſaid) could not but be a Chriſtian; and who was not content to be himſelf an offender againſt the laws, but had dared to reſcue another offender from the puniſhment, to which they had doomed her.

AGAINST this charge, the undaunted *Didymus* being aſked, what defence he had to make, addreſſing himſelf to the judge, made this reſolute anſwer: I ſtand accuſed of a twofold crime, of being a Chriſtian, and of *Theodora*'s reſcue: and though I cannot ſo ſoon have forgot, how heinous my accuſers have endeavoured to make them appear, yet, inſtead of denying either of them, I ſhall own, that I glory in both.

As for Chriſtianity, in an age, wherein it is ſo cruelly perſecuted, I would not have embraced the profeſſion of it, but that I was reſolved, if there were occaſion, to ſuffer for it. And therefore I ſhall neither deny what they call a crime, nor make an apology for it, nor deprecate any infliction, (for ſo I call it, rather than puniſhment, which ſtill ſuppoſes a fault) whereto it can expoſe me. Nor could I, without being wanting to the duty of humanity, refuſe my aſſiſtance to preſerve the purity of ſo noble a ſhrine of chaſtity, as the ſavage deſigners of a rape on *Theodora* were going barbarouſly to violate. And the inward ſatisfaction of having done what became me on ſuch occaſions, will ſupport me under any ſufferings, that ſhall be drawn upon me, but by my loyalty to perſecuted truth, and my compaſſion of diſtreſſed virtue.

THE experience I have had, (anſwers the preſident) of the effects of thoſe deſperate errors you miſcall religion, makes me inclinable enough to think, that you, as well as many others of your wild ſect, have both madneſs and impiety enough to put off the apprehenſions, as well as the other common ſentiments, of human nature, and fear death, as little as you do the Gods. But ſince you pretend to be more virtuous men, and obedient ſubjects, than others; pray tell me, what you can ſay, for your reſcuing a malefactor out of the hands of thoſe miniſters of juſtice, that were going to execute the ſentence of condemnation upon her?

IF, replies *Didymus*, the ſentence you ſpeak of had doomed her to death, though I ſhould moſt gladly have ſuffered it in her ſtead, yet I had deplored your cruelty, without attempting to defeat it. But I confeſs, I could not, without indignation, as well as grief, ſee ſuch a perſon as *Theodora*, who for her beauty, virtue, and other perfections, is juſtly admired by all, that know her, and looked upon as the honour of her ſex, moſt injuriouſly condemned to ſo infamous and barbarous an uſage, as were unfit for the meaneſt and deſpicableſt of creatures, that belong to the ſex, whereof ſhe is the ornament. And conſidering with myſelf, that chaſtity in women, and eſpecially in virgins, is ſo much a virtue, and their right to preſerve it ſo confeſsedly inherent, that all nations agree in aſcribing to them a right to defend it, without reſerve, againſt whoſoever attempts to deprive them of it, I concluded, that to help a diſtreſſed virgin to preſerve ſo acknowledged a right, was to defeat raviſhers, rather than to oppoſe magiſtrates, and not commit a crime, but hinder the accompliſhing of one. Nor could I think, that it was againſt the Roman judges I acted, when I oppoſed perſons, whom their ſavage deſign made me look upon as the worſt ſort of Barbarians. And I did not doubt, Sir, (continues *Didymus*) that in your own breaſt, when calmer thoughts ſhall come there to ſucceed thoſe, that lately poſſeſſed it, I ſhall be abſolved from an action, which kept you from diſhonouring yourſelf as much, as the execution of your ſentence would have defiled *Theodora*; and kept you innocent as to act, from what would have made you enemies for ever, not only of the faireſt half of mankind, but of all thoſe of our ſex, that retain any ſparks either of virtue or good nature.

IF *Theodora*, (replies the preſident) were not a beauty, and one of your obſtinate ſect, I doubt you would never, for her ſake, have adventured upon ſo deſperate an attempt, as makes you not more diſobedient than obnoxious to the law.

I SEE not, Sir, (rejoins *Didymus*) why it ſhould be a diſparagement to *Theodora*'s beauty, or to the impreſſions I have received of it, that all, that it has engaged me to do, has been, with the utmoſt hazard of my life, to reſcue her purity, and deny myſelf, in the firſt place, the advantages I endeavoured to deprive others of. But the charms of her mind needed not thoſe of her face, to make me attempt to preſerve her. I have often in camps contended, not without hazard enough, with my victorious fellow-ſoldiers, to keep them from violating the chaſtity of captives, who had neither beauty to captivate others, nor any thing elſe to engage me in their quarrel, except their being innocent and diſtreſſed women. But *Theodora*, ſetting her beauty and birth aſide, has been ſo eminent, for all the good qualities and excellencies, that can accompliſh a perſon of her ſex, and eſpecially for her chaſtity, that my heart would have reproached me for not prizing virtue enough, if I had declined ſo happy an opportunity, to expreſs the veneration I paid ſo ſhining a one, as hers. But, (purſues *Didymus*) I would not, by what I have ſaid, be thought to deny, that my religion had a ſhare in the attempt I made to ſerve a perſon, that did ſo much adorn it, and was ſo loyal to it. The Chriſtian doctrine, among many other excellent things, that it preſcribes to its embracers, teaches them, that in ſome caſes, among which ours is comprized, they *ought to lay down their lives for one another*. But, Sir, (concludes *Didymus*) you may be pleaſed to take notice, that what I acted was according to the rules of it too: for I did not oppoſe the execution of your cruel ſentence by force, but only prevented it by an innocent ſtratagem, whereby my ends were obtained without bloodſhed or violence; no man's life having been ſo much as endangered, except my own, which I never thought myſelf bound to preſerve from any danger, that piety or humanity ſummoned me to undertake.

1 John iii. 16.

THOUGH the preſident could not but be ſenſible, that *Didymus* had ſaid more for himſelf, than was expected; yet, that he might not be thought to be ſatisfied with the defence of a perſon, whom he meant to condemn, he told him; I do not think it ſtrange, that thoſe, who dare call the very worſhip of the gods ſuperſtition and idolatry, and that, which all men but yourſelves call impiety, religion, ſhould ſtyle rebellion againſt the magiſtrate, loyalty to the truth. But how induſtriouſly ſoever you ſtrive, not only to cloak a criminal action, but transform it into a virtuous one, I can eaſily, through all its diſguiſes, perceive the diſobedience and refractorineſs to civil government, that is ſo contagious, and ſo ſpread among the embracers of your ſect, that princes have no other way, but your ruin, to ſecure their own ſafety, which would be quickly endangered, if your power and numbers were half as great, as the diſloyalty of your principles and practices.

TO be a ſufferer for my religion, (anſwers *Didymus*) is that, which I ſhall not ſo properly ſubmit to with reſignation, as embrace with joy: but to find my religion a ſufferer with me, if not for me, and to ſee Chriſtianity made a ſtate-crime, while it ſeverely prohibits and condemns all crimes, and none more expreſly, than diſobedience to the juſt commands of magiſtrates; is that, which I confeſs, does not a little trouble me; and therefore, Sir, I hope you will allow a perſon, that is much more concerned to keep his religion, than himſelf, from being endangered by this accuſation, to give you a righter apprehenſion, than our calumniators have done, of the innocenteſt, as well as the trueſt, religion in the world.

THOUGH, for my part, (continues *Didymus*) I think, that the liberty of ſerving God, by ſuch ways, as are not repugnant to the light, or laws of nature, or the welfare of civil Societies, is the common right of mankind, and cannot be denied man, without injuſtice; yet I do not now plead for it; and you are more concerned to look to that, than I. For if you make me ſuffer, for the innocent uſe of that right, which God and nature have granted unto all men, I ſhall but undergo a tranſient puniſhment; but you will expoſe yourſelf to an eternal, and (which is worſe) to a deſerved one. No perſons in the world can pay more obedience to the laws of their ſuperiors, than Chriſtians do. We, that can ſhed the enemy's blood, and hazard our own, as freely, and perhaps as ſucceſsfully, as any ſoldiers in your armies, ſuffer you to ſhed ours, as tamely as any ſheep you have in your folds. And ſure, we are very unhappy, as well as you very incredulous, that thoſe profeſſions of loyalty and obedience, that are not more viſibly written in our books, than frequently ſigned with our blood, cannot gain credit with you; nor our death itſelf convince you, when the wounds, that we quietly ſuffer to pierce our breaſts, would open you windows into our hearts, if ſome had not a greater mind to pierce them, than to know them. But the ſame juſt care we have to obey authority, what rate ſoever the ſubmiſſions coſt us, forbids us to do thoſe things, for the refuſal whereof authority condemns us. For God being, as the only creator, ſo the ſupreme governor of man, his laws are thoſe of the trueſt ſupreme authority: and princes themſelves being his ſubjects, and but his lieutenants upon earth ; to decline their commands, whenever they prove repugnant unto his, is not ſo much an act of diſobedience to the ſubordinate power, as of loyalty to the ſupreme and univerſal ſovereign. And in ſuch caſes we are no more rebels againſt the emperor, when we prefer the performance of God's laws to a compliance with his, than we ſhould be, in caſe we ſhould diſobey the orders of the governor of the province we live in, if they ſhould prove repugnant to thoſe of *Auguſtus*. And even in theſe caſes, if we cannot yield an active obedience to the commands of the civil ſovereign, we do not refuſe him the utmoſt we can conſent to, which is paſſive obedience : and when our conſciences permit us not to do thoſe, to us, unlawful things, that he commands, they enjoin us to ſuffer unreſiſtedly, whatever penalties he pleaſes to impoſe. And give me leave, ſir, to add, (ſo *Didymus* continues) that we are ſo far from making religion a cloak to the purſuit of preſent advantages, that you daily ſee us renounce them all, and our lives to boot, to maintain our loyalty to our maker, without hopes of being recompenſed, but in another world ; and even there we cannot expect any, but by the ſentence of a judge, whom none can either bribe or deceive, and who is more ſevere to crimes, than any perſecutor on earth can be, to innocents. I will not tell you, purſues *Didymus*, that, on the other ſide, the aſſurance we have of the ineſtimable rewards laid up in heaven for loyalty to God and his truths, the internal applauſes of a good conſcience, are things of ſo elevating and ſatisfying a nature, that our religion can make the hearts it poſſeſſes, not only deteſt the ambition of thoſe ſubjects, that aſpire to earthly crowns, but perhaps pity the condition of thoſe princes, that poſſeſs them. But I dare, ſir, avow, that the harmleſſneſs of our principles is not more legible in our profeſſion, than in our practices and ſufferings. For the multitude of Chriſtians is ſo great, that [in your cities, your country, your courts of juſtice, your camps, and all places of publick reſort, except your temples, they are not only preſent, but numerous ;] and your enemies, as well as your armies, have been ſufficiently convinced they know as well, how to kill, as die : ſo that it is only becauſe we will not forfeit our innocence, by a forbidden way of defending it, that we are expoſed to ſuch cruel ſufferings for it. And I doubt not but equitable eſtimators of things will conclude, that our calmly ſubmitting to ſuch inhuman uſages ſufficiently ſhews, that we do not deſerve them.

Tertul.

THE judge diſcerning ſtill more clearly, that his diſcourſes made much leſs impreſſions upon *Didymus*, than thoſe of *Didymus* did upon the hearers, reſolved to break off this kind of converſation, and with a ſtern countenance, told the priſoner, that it was high time for him to remember, that he was a judge, and not a prieſt ; and that therefore, though his compaſſion had hitherto invited him to employ perſuaſions, yet now their unſucceſsfulneſs obliged him to declare poſitively, that he was ſure the gods, that he and the world worſhipped, were the true ones ; and that if *Didymus* did not forthwith acknowledge them to be ſo, by ſacrificing to them, he ſhould quickly feel their power, by being put to a death, his obſtinacy made him both deſerve and appear fond of.

DIDYMUS, without ſeeming to be at all moved at this rough language, calmly, as well as reſolutely, replied :

THOUGH, ſir, I am moſt ready, whenever I am called to it, to ſuffer for my religion, yet I would not be thought to expoſe myſelf, for an obſtinate denial, to hear and conſider, what may be objected againſt it. We Chriſtians, whatever wilfulneſs may be miſimputed to us, are not ſo fond of ſufferings, or of our own conceits, as not to be more willing to have them brought to the bar, than to be condemned there for them : and perſecuted opinions are things, which, as we do not renounce, ſo we do not embrace, for their being ſuch. Nor are we ſo blind and wilful, as to reject clear arguments, that would both inſtruct us and reſcue us too, if any ſuch could be propoſed by the embracers of your religion.

This I ſay, ſir, continues *Didymus*, not to contradict what you were ſaying of your being not a prieſt but a judge ; but to clear conſtancy from the imputation of obſtinacy, and declare, that if we could ſee reaſons on your ſide, fitted to deliver us from error and from death, we would not be ſo mad, or ſo perverſe, as to chuſe rather to renounce life, than embrace truth. But pardon me, ſir, (ſubjoins he) if I think, that though you are commiſſioned by the ſupreme power to be a judge for life and death, yet you are not conſtituted by the ſupreme verity a judge of truth and falſhood : and therefore, I take your owning to worſhip many gods, who, by their very being many deities, are ſufficiently proved not to be true ones, for a declaration of your opinion, not a demonſtration, that it ought to be mine too. If you preſs us with arguments, we are ready to anſwer yours, and offer you ours ; but when, inſtead of them, you employ threats, we do not think it proper to argue againſt them, but to deſpiſe them ; ſince it is not our reaſon, that they aſſault, but our conſtancy. And therefore, give me leave to tell you, ſir, concludes *Didymus*, that the Chriſtian religion can ſo fortify and elevate the mind, and place it ſo much above the reach of a political juriſdiction, that I ſhall ſuffer your ſentence with far leſs trouble, than you will ſoon or late feel at the remembrance of your having pronounced it ; and you will not find it in the power of all your executed threats, to ruin either my conſtancy, or ſo much as my joy.

THE judge, enraged to ſee his power thus deſpiſed, and, as he interpreted it, affronted by a priſoner, declared, he would defer no longer than one hour (which ſpace he allowed him to repent his errors in,) to pronounce againſt him the fatal ſentence, and commanded him to be immediately led to the place, where it was to be executed; towards which he himſelf intended to follow at ſome diſtance; whether it were to feed his cruel eyes with a ſpectacle, whoſe tragicalneſs his revenge would make acceptable to him; or to prevent any tumult or diſorders, that the courage of *Didymus*, and the eſteem and pity it had excited in the numerous by-ſtanders, might poſſibly occaſion.

CHAP. VII.

AS ſoon as the gentleman, that made the paſt diſcourſe, had ended it, the juſt idea it formed in the minds of the hearers, and eſpecially of the two ladies, of the ſingular piety and heroic courage of *Didymus*, made ſuch an impreſſion on the grateful and compaſſionate *Theodora*, as exceedingly heightned her reſolution to reſcue him, if it were poſſible, and haſtened her to begin immediately to attempt it. In order to which, having obſerved, that the hearers liſtened ſo attentively to what the relator ſaid, that they then minded nothing elſe, ſhe took that nick of time to withdraw herſelf ſilently into another room, and by a pair of back-ſtairs, conveyed herſelf out of the houſe; whence by indirect ways, (for fear of being overtaken in the ſhorteſt,) ſhe went with as much haſte and gladneſs to an almoſt certain death, as others are wont to ſhun and eſcape it with; leaving *Irene* and her other friends, no leſs amazed than troubled, when ſometime afterward they perceived her miſſing, and found all the diligence they employed to retrieve her fruitleſs: for, *Theodora*, fearing ſhe could not long eſcape the diligence of her purſuers, unleſs ſhe haſtened to a place, where ſhe juſtly thought they would not follow her, delayed not to go directly towards the company, that ſhe was told attended the preſident in the affairs, that were tranſacting in his court. Among theſe attendants ſhe had not ſtaid long before ſhe deſcried her brave lover under a ſtrict and rude guard, but with a look ſo manly, and ſo ſerene, as ſhewed, that he deſerved another uſage, and was not in the leaſt daunted nor diſcompoſed by that he met with. This moving ſight ſo affected the generous and compaſſionate *Theodora*, that though in ſo publick place and manner ſhe could with leſs reluctancy die for *Didymus*, than ſhe could plead for him; yet her gratitude ſurmounting her baſhfulneſs, after ſome conflict within herſelf, ſhe made towards the tribunal; to which ſhe found a more eaſy paſſage than ſhe expected: for the advantageouſneſs of her ſhape and ſtature, and gracefulneſs of her motions, eaſily produced for her ſuch ſentiments in the admiring by-ſtanders, as made them with great reſpect give her way, and let her, without diſturbance, paſs on to the bar. She had but a very little while ſtaid there, before the preſident was moved by the concourſe of thoſe, whom curioſity and wonder invited to gaze on the fair ſtranger, to caſt his eyes on her; and notwithſtanding the unlikelihood, that ſhe ſhould appear there, without having been forcibly brought thither, as ſoon as, out of reſpect to his dignity, ſhe had lifted up her veil, he diſcerned, that it was ſhe, by a ſort of beauty ſo peculiar, as was not eaſily either to be met with in others, or to be forgotten by any, that had ever ſeen it.

BUT though the judge were thus ſurprized at her preſence, yet he little leſs admired her courage, than her beauty, when, with a face, wherein the bluſhes of her cheeks, and the aſſuredneſs of her looks, equally diſcovered her modeſty and her fearleſsneſs, ſhe told him, I know, ſir, that it is a very unuſual thing, for a perſon of my ſex and religion, to come to this place unſent for: but I hope you will be pleaſed to conſider, that, as the action is extraordinary, the occaſion of it is ſo too. For both virtue, the juſtice, that you ſit here to diſtribute, and gratitude founded upon the higheſt obligations, engage me to appear before you on the behalf of that brave priſoner, (at which words ſhe pointed at *Didymus*,) and preſent you the object, on which you may inflict with legal juſtice, what you cannot make him ſuffer, without being taxed of cruelty. For ſuppoſing a debt to be due to the law, yet it would be more ſevere, than juſt, to proſecute the ſecurity, now the principal offers to pay the debt. He may well be looked upon as my hoſtage, whom I now come to redeem; and it is not, ſir, your intereſt to decline the exchange, ſince by it you will preſerve a perſon, whoſe courage, engaged by his gratitude, may do ſignal ſervice in the Roman army; and ſince my eſcape was all his crime, I beſeech you let my ſurrender of myſelf obtain his abſolution.

HERE *Theodora* pauſed a while, partly to recover from the diſorder ſo unuſual and difficult an effort of her modeſty had put her into; and partly to obſerve the judge's countenance, upon his hearing, what ſhe had ſaid, and to take meaſures thence, in what ſhe was further to ſpeak. The preſident in the mean time continued ſilent, whether the longer to hear the muſick of her voice, or becauſe ſo many charms, as nature had crouded in her face, and ſo much ſadneſs, as her concern for her lover had diſplayed in her looks, had ſomewhat mollified him, as they might have done a tiger. Whereupon the fair ſuppliant hoping, that his not interrupting her proceeded from ſome relenting thoughts, reſumes her diſcourſe in theſe terms: but if, ſir, to procure the diſmiſſion of this gentleman, your juſtice had need to be ſeconded by your clemency, perhaps you never had, nor never will have, an object, whoſe merit may ſo well warrant the exerciſe of it. For his life, ever ſince he bore arms, has been employed in the ſervice of his princes, and fearleſsly hazarded for their greatneſs. And the action, for which he is now in trouble, is ſo heroick, and ſo diſintereſted an one of courage and compaſſion, that in it he could ſcarce have any other motive, than the greatneſs of his generoſity, nor other end, than the exerciſe of it. Nor need you fear, that your clemency on this occaſion ſhould introduce a bad example; for this of *Didymus* is never like to be imitated, nor can be ſo, but by perſons too virtuous to be delinquents: and if ſuch actions be criminal, at leaſt it is unlikely they will grow common crimes. And here *Theodora* perceiving, that the impatient *Didymus* (now come again to himſelf, after the aſtoniſhing ſurprize this adventure gave him) was upon the point to interrupt her, ſhe thus prevents him. And you, brave *Didymus*, forbear to oppoſe the accompliſhment of my juſt deſires. The courſe, that I now take, is the only, that I could take, to evidence my gratitude, and to let you ſee, that you have not exerciſed the nobleſt acts of generoſity and friendſhip towards a perſon inſenſible of the dictates of thoſe virtues. I could not (continues ſhe) but be glad to be reſcued from the ignominy of a rape; but I did not intend to be robbed of the glory of ſuffering for Chriſt; which is alſo the only means left me to evince, that I declined diſhonour, and not death, and never meant ſo much to diſoblige the world, as, for the ſake of an inſignificant maid, to deprive it of one of the moſt generous of men. You have left yourſelf but one way to increaſe your paſt favours, which is, to allow me the only real expreſſion I can make of my ſenſe of them; and that in ſuch a way, as can at moſt but make ſome little diminution of them, without pretending to make a retribution for them. If therefore (concludes ſhe) you will compleat the obligation you have laid on me, by preſerving to me the coronet of virginity, you muſt not oppoſe my obtaining the crown of martyrdom.

DIDYMUS had need of all the reſpect, that he paid his admirable miſtreſs, to keep him thus long, from interrupting a diſcourſe, that tended ſo little to his ſatisfaction; and therefore ſhe had no ſooner put a period to it, than (with a deep ſigh) he told her; Ceaſe, *Theodora*, ceaſe, to plead for the continuance of life, that you are almoſt as cruel to me, in thus endeavouring to preſerve, as you are, in thus hazarding your own. And if I durſt not hope for, from the preſident, more than I ſee I muſt, on this occaſion, expect from you, I ſhould think myſelf as perfectly wretched, as (whatever your intentions be) your proceedings are unkind. But I am confident our unbiaſſed judge is too impartial, not to diſcern in your diſcourſe, that the exceſs of your goodneſs has had the chief intereſt in the management of your plea; the caſe, about which we differ, being in itſelf ſo clear, that alone to ſtate it, is ſufficient to plead it on my behalf. For I enticed you to eſcape out of priſon, and then, at my own peril, facilitated to you the means of doing ſo: you leave me behind as a pawn to the laws, and theſe, finding me in your room, make their great miniſter, before whoſe tribunal we ſtand, doom me, for your offence, to the death deſigned for your puniſhment; which ſince I joyfully proffer myſelf to ſuffer for you, or rather, ſince you ſuffer it in me your proxy, the illuſtrious preſident is too well acquainted with his office, to need to be told, that, at leaſt in equity, the ſurety's payment diſcharges the principal from the debt; eſpecially, when he not only proffers the payment, but moſt earneſtly deſires the acceptance of it, as a great advantage to him. I hope then, great ſir, ſays he, (turning himſelf to the preſident, with additional reſpect to that he had ſhewed him before,) that you will accept of my life inſtead of hers, who deſerves a long and happy one; and that, when my ſentence of condemnation ſhall be pronounced, and gladly acquieſced in, it may free her, I am condemned for. The love of ſelf-preſervation is ſo natural, that it cannot be made capital, without affronting nature, and puniſhing as well, what men are, as what they do: and the love of purity and honour does ſo much become a chaſte virgin, that the natural conſequences of it are too commendable to be fit to be made penal. It is I, who having deſpiſed dangers, that I might eaſily have avoided, when it was queſtion to do an illegal thing, do yet glory in the crime, that am the juſt and proper object of the rigour of your laws: and her years are yet ſo tender, and her diſpoſition ſo innocent, that ſince, if ſhe have erred, it was by my perſuaſions, if ſhe be to be puniſhed, it ſhould be in my perſon. All that ſhe has ſince alledged to appropriate my guilt, or involve herſelf in it, will, I hope, by a Roman magiſtrate be looked on, as it is indeed, as an argument of her generoſity, and not of her crime. And the Romans are too much friends to gallantry, to puniſh in a lady that virtue, that they applaud and crown even in ſoldiers.

BUT now, continues *Didymus*, I muſt addreſs myſelf to you, O *Theodora*; and muſt complain of, or at leaſt deplore, my infelicity, that after I had done and ſuffered all that I could, though it was much leſs than I would, for the preſervation of ſo dear a life as yours; you come now to hazard it, to make mine end with ſorrow. But granting you ſhould prevail in the no leſs unwelcome, than generous attempt, you are pleaſed to make, how cruel were you, to envy me at once, the two higheſt honours, that my ambition aſpired to; the glory of martyrdom, and that of *Theodora*'s reſcue! Had I as many lives, as you have virtues, I ſhould eſteem them all but a cheap ranſom for a few hours of yours; ſo unlikely I am, and ought to be, to be either capable or deſirous of being preſerved by your ſuffering for my actions. And therefore, madam, if you think my little ſervices deſerve ſome recompence, ſince my higheſt contentments on earth terminate in your happineſs, there is no other way left you to reward them, but the care of your own preſervation; it being the only return, that I expect or deſire of my ſervices, that you will not, by your inflexibleneſs, finally make them fruitleſs; but be content to live for his ſake, that will rejoice to die for yours.

All the while this noble diſpute laſted, the judge was, though not an unconcerned, yet a ſilent hearer of it; the ſtrange novelty of the conteſt, and no leſs extraordinary generoſity and gracefulneſs of the contenders, having given him an attention, that kept him from interrupting them. But when their debate had proceeded thus far, his ſtern nature, whoſe actings had been but ſuſpended by his curioſity, prompted him to tell the generous couple; I know not what preſumption makes you plead, as if each of you were the other's only judge, and had the ſupreme authority of condemning or abſolving you; and I were only an unconcerned auditor, or at leaſt ſate here to ratify the ſentence you ſhall agree upon between your ſelves: but you will quickly find, to your coſt, that the Roman laws and magiſtrates are not to be trifled with.

Great ſir, replies *Didymus*, you much miſapprehend our conduct, if you think yourſelf ſlighted by it: for it was not want of reſpect to your authority and power, that made us diſcourſe as we did; but a ſuppoſition, not injurious to you, that you would in the exerciſe of that power manifeſt, that you deſerve it, by tempering it with two excellent virtues, that beſt become a magiſtrate, equity and clemency. This preſumption, ſir, and not any diſreſpectful one, was that, upon which we proceeded in our diſcourſe; ſtill taking it for granted, that you would not puniſh two, for that, which was indeed but the fault of one; and that if either of us were, by the other's conſent, to ſuffer, your equity, or your clemency, would prevail with you to releaſe the other.

Though *Didymus* had worded what he ſaid ſo cautiouſly, that a diſcerning hearer might perceive, that his expreſſions related to the judge's dignity, not his perſon; yet that ſelf-flattery, which is but too common an attendant on men in power, making the preſident take all theſe reſpectful words to himſelf, made him allow *Didymus*, without interruption, to proceed in his diſcourſe, and ſay; You will eaſily grant, ſir, that goodneſs, whereof clemency is a noble part, may bring a magiſtrate, who is heaven's vicegerent upon earth, as high a veneration, as power or greatneſs does; if you pleaſe to conſider, that thoſe of your religion, when they would with the moſt deference ſpeak of God, give the title of moſt good the preference to that of moſt great, ſtyling him, as the Chriſtians likewiſe often do, *Deus optimus maximus*. Certainly, clemency is never more a virtue, nor leſs grudged at by juſtice, than when it is exerciſed towards virtuous perſons, by reſcuing them from the perſecutions of fortune, and the unintended rigour of the laws. I ſay unintended rigour, ſays *Didymus*; for I cannot think, that the Roman legiſlators, that have honoured injured chaſtity ſo much in *Lucretia*, and encouraged gallantry and other virtues, by no leſs than crowns and triumphs, meant to make the productions of chaſtity, conſtancy and gratitude, criminal things. And though Chriſtians diſſent from others in matters of religion; yet thoſe moral virtues, that were ſo eſteemed by the Romans, do not loſe their nature, when practiſed by Chriſtians: and thoſe brave men, whoſe love to virtue made them maſters of the world, did not ſcruple to honour it in their very enemies; and did it ſo much, even in the moſt irreconcilable of them, that more than one or two ſtatues of *Hannibal* were erected at *Rome*; to which triumphant city it is perhaps more glorious, to have thus honoured him, than vanquiſhed him. And ſure they, that thought *Lucretia*'s chaſtity merited ſo many ſtatues, would not think that *Theodora*'s deſerved a ſtake or a ſcaffold. This lady's actions and mine are not ſo heinous, but that in happier perſons, and milder times, they have been looked on under a notion very differing from that of criminal ones. But ſir, continues *Didymus*, addreſſing himſelf to the preſident in a very humble manner, if there muſt needs be offered up ſome ſacrifice to appeaſe the angry laws, I beſeech you to let their rigour be ſatisfied with my blood, and ſpare this harmleſs lady; to whom, if your compaſſion be needful, I hope you will not want it for an object, whoſe excellencies cannot only make it reaſonable but meritorious. For it will preſerve to *Antioch* its faireſt ornament, and a life ſo exemplary, that to give it an untimely period, for actions, which, being laudable in their own nature, nothing but a rigid interpretation of the law can make criminal, would be to make the laws a terror, rather to the good than to the wicked. It would be thought inhuman to treat her as a delinquent, whom you may juſtly wiſh your daughters ſhould reſemble; when by the grant of what I implore, you will be ſure to receive both the thanks of her ſex, and the applauſe of ours, and, what outvalues both, the ſatisfaction of having ſaved and obliged one of the moſt admirable perſons in the world.

Didymus now perceiving, that the perſon he pleaded for was preparing herſelf to interrupt him, re-addreſſed himſelf to her, and told her; Do not, madam, I beſeech you, require of my obſequiouſneſs proofs inconſiſtent with my love; and add not to my infelicity, by putting me in ſo uneaſy a condition, as to find it my duty to oppoſe your deſires. Ah! refuſe not to oblige the world, by preſerving the moſt accompliſhed it can glory in: deny me not the ſatisfaction, whereof I am ſo ambitious, of being the happy inſtrument of your deliverance; and then I may ſay, that I never could juſtly die more ſeaſonably than now, when being at the height of all my joys, my longer life muſt of neceſſity give an ebb to my felicity; ſince, after the glory of having ſaved *Theodora*, I hope for no higher on earth, than that of dying

ing for her. Then perceiving her ready to renew the conteſt, he told her, (with a low voice, that the judge might not hear him, and with a ſadneſs in his looks, which ſhe, that knew his courage, could impute to nothing but his almoſt boundleſs concern for her) Madam, though the preſident's impatience did not call upon us to conclude our conteſt, yet *my* condition and reſolution ought to put a haſty period to it. For, madam, I muſt poſitively declare to you, that it would be as bootleſs as cruel, for you to think to protect my life, by the abandoning of your own; ſince to owe a life to that cauſe, would make it not only uneaſy but inſupportable to me, and conſequently uncapable of laſting: ſo that enjoining me to ſurvive you, would condemn me to a life, which, after the loſs of yours, muſt be ſpent, if it could laſt, in fruitleſly deploring that loſs. Forbear therefore, concludes he, I moſt earneſtly beſeech you, madam, to exact ſuch proofs of my obedience, that it is as little in my power to give you, as it ought to be in your will to require them; ſince for *Didymus* to ſurvive *Theodora*, is as great an impoſſibility, as it would be an unhappineſs. O admirable conteſt! where the noble antagoniſts did not ſtrive for victory, but death; or endeavoured to overcome each other, that the victor might periſh for the vanquiſhed: where ſelf-love, the moſt radical affection of human nature, is ſacrificed to a love equally chaſte and diſintereſted; and where virtue makes each of the contenders ingeniouſly ſolicitous to appear criminal, that the antagoniſt may be treated as innocent. How well does this proceeding prove that inſpired ſentence true, that *love is ſtronger than death*; ſince, in this conflict, the generous friends are by the former made rivals for the latter!

CHAP. VIII.

THE afflicted virgin, to whom theſe moving things were ſaid, finding, that ſhe ſhould but loſe her diſſuaſions on *Didymus*, thought fit to addreſs herſelf once more to the preſident; and with humble geſtures, accompanied with looks, and with a voice, that would have ſoftened any, that were not invincibly obdurate, ſhe told him, Though, Sir, the arguments uſed by this gentleman had far better proved than they have, that of us two, he is the fitteſt perſon to be condemned; yet I hope, where you preſide with ſo much authority, he will not fare the worſe for being generous; and that what he has done, will be more prevalent with you, than what he has ſaid. Ever ſince he was capable of bearing arms, he employed them in the ſervice of the Emperors; and in their camps chearfully followed the Roman eagles, whereever they durſt fly: and after his having this day hazarded himſelf ſo generouſly, out of compaſſion to a diſtreſſed virgin, what examples of gallantry may not be expected from ſuch a courage, engaged by his gratitude, when he ſhall act for the acqueſt of glory, and the ſervice of his country? If a guilty intention be neceſſary to make an action ſo, his will not be found to be criminal; ſince he did not intend the violation of any law, but to ſecond, what we are told to be the deſign of all juſt laws, which is to protect the innocent, and encourage virtue. But, if by a rigid interpretation of the law, he may be brought within the reach of it, I hope his miſdemeanor will not appear ſo great, but that your clemency may allow him all, that I beg for him, which is, that he may be permitted to repair a miſtake in the exerciſe of his virtue, by the continuation of thoſe ſervices in the Roman army, which will be far more uſeful to the public, than his death, in his preſent circumſtances, can be. To this *Theodora* would perhaps have added, (though ſhe could ſcarce have done it, without ſome reluctancy from her modeſty) The things, Sir, that he has been pleaſed to act and hazard for me, may perſuade you, that if, contrary to my prayers and hopes, you ſhould deſign ſeverity towards him, you may more ſenſibly puniſh him by my death, than by more immediate inflictions on him. And it is like ſhe would have enforced her arguments and entreaties for a perſon, for whom ſhe was ſo much and ſo juſtly concerned, when the preſident, vexed to find, that both of them ſo little valued life, whoſe deprivation was the moſt formidable thing he could threaten them with, prevented her, by ſaying, with a ſtern countenance, No, I will hear no more, having heard but too much already. It does not become a Roman magiſtrate to ſuffer any longer with patience, that priſoners and criminals ſhould daringly diſobey the laws, ſlight all their threats, and glory in their violation. What each of you has ſaid to prove himſelf guilty, affords abundant reaſon to condemn you both: wherefore, ſince you cannot agree among yourſelves, I will be your umpire, and give both of you what each deſires and merits. You, obſtinate maid, ſays he, turning to *Theodora*, ſhall die for having broken priſon; you diſobedient ſoldier, ſays he, to *Didymus*, ſhall die for having perſuaded and furthered her eſcape: but to ſpecify your chiefeſt crime, than which there needs no other, nor can be a greater, you both ſhall die, becauſe you are Chriſtians, and conſequently enemies to the Roman Emperors, and the gods, that made them ſo.

THIS fatal doom being pronounced, the judge ordered the condemned priſoners to be taken aſide, and ſtrongly guarded, till all things were in readineſs for their execution; which preparatives he gave order to haſten: yet finding by the diſcontented looks, and confuſed murmurs of the by-ſtanders, that the charms and innocence of *Theodora*, and the youth, courage and friendſhip, of both the no leſs generous than unfortunate priſoners, made his ſentence to be far leſs liked, than were the perſons and behaviour of thoſe it paſſed upon, declared, that whilſt he was diſpatching other public buſineſs, he permitted any, that ſhould have charity enough to make a hopeleſs attempt, to endeavour to convert thoſe obſtinate miſcreants; adding withal an intimation, that even they might ſpeed in their ſuit, if they would ſeaſonably, with incenſe in their hands, flie to the altars of the gods, and humbly implore of them pardon and ſafety.

This reſpite, as it expoſed the generous couple to have their conſtancy aſſaulted by infidels ambitious of making ſuch illuſtrious perſons proſelites, ſo it gave them the welcome opportunity of interchanging ſome diſcourſe with one another.

These conferences were begun by *Didymus*, who ſeeing himſelf upon the point of final ſeparation from his admirable miſtreſs, could not forbear feeling in himſelf ſuch diſorders, as, on all other ſad occaſions, his great courage had kept him from reſenting: and this unuſual commotion of mind, was uneaſy enough to oblige him to ſay, to the fair perſon, that occaſioned it, Though, madam, the military courſe of life I have with ſome forwardneſs purſued, has accuſtomed me to meet death in variety of formidable ſhapes and dreſſes, without being diſcompoſed by it; yet when I ſee the world going to be robbed of its nobleſt ornament, and myſelf to be deprived of the perſon I moſt love and admire in it; and when I ſee this matchleſs perſon ready to be raviſhed from us, both in the flower of her age, and by the infamous hand of an executioner, I think it were rather ſtupidneſs not to be afflicted, than any weakneſs to be deeply ſo.

I was, anſwered *Theodora*, ſo fully ſatisfied before of your friendſhip and compaſſion, that this new grief of yours, as it is a very needleſs proof of them, ſo it is a very unwelcome one: for, if I were to allow any thing to grieve me, when I am entering into *the fulneſs of joy*, it ought to be, that I find your good-nature renders this ſeemingly diſtreſſed condition of mine very uneaſy to you, which, through God's aſſiſtance, is very little ſo to me; and yet will be leſs ſo, if, congratulating rather than deploring our martyrdom, you will eaſe me of the juſteſt and greateſt part of my grief, that conſiſts in being unhappily acceſſary to yours, and ſeeing you needleſly troubled at mine. That circumſtance, adds ſhe, of my death, which I perceive much afflicts you, might, in my opinion, more juſtly leſſen, than aggravate your ſorrow: for I look upon it rather as a favour, than an infelicity, that I am early removed out of the world, where I ſee, and ſuffer, and (which is worſt of all) do ſo much ill. To be early reſcued from the ſnares of a dangerous and perſecuting age, and preſerved *from the evil to come*, is rather a privilege, than a calamity, to thoſe that are duly ſenſible, as I deſire to be, that one can never arrive unſeaſonably at heaven, nor be too early happy. And, in this perſuaſion (continues *Theodora*) I am confirmed by conſidering, that the firſt of thoſe, who are recorded to have religiouſly deceaſed, in the old teſtament, and in the new, juſt *Abel* and *John the Baptiſt*, both of them died young, and periſhed by the hands of thoſe that perſecuted them for their piety: and even that ſpotleſs Lamb of God, *who did no ſin*, but by his ſatisfaction, precepts, and example, *takes away the ſin of the world*, was ſacrificed almoſt in the flower of his age; ſo little is it an unhappineſs, or a mark of God's diſfavour, to eſcape the toils and dangers of a troubleſome navigation, by being early, though by a boiſterous wind, blown into the port. And if it could become a woman to encourage a hero, I ſhould exhort both you and myſelf too, generous *Didymus*, (continues ſhe) to entertain our preſent condition with ſentiments becoming Chriſtians. And, as it does not trouble me directly, ſo it ought not to trouble you upon the ſcore of ſympathy, that I am ſecured from the hazards and inconveniencies of age; but be pleaſed to make uſe of that courage, now at the end of your days, that you have conſtantly expreſſed in the courſe of your life; and, do not, I beſeech you, repine, either that you or I is to fall by the hand of an executioner: for that ſeeming, and but ſeeming ignominy, was the lot both of our Saviour's immediate harbinger, and of our Saviour himſelf; and when we conſider for whom, and for what we ſuffer, we may find reaſon enough to aſſume the ſentiments of the apoſtles, who, after having been miſuſed by the Jewiſh council, *went from their preſence rejoycing, that they had been thought worthy to ſuffer for his name*; for whom we are going to ſuffer the like things; for, *Didymus*, God's gracious providence has not left us to periſh, by lingering or tormenting ſickneſs, or troubleſome old age, nor yet for ſome common cauſe, or ſome unimportant end; but all in our fate is noble; and what to others is meer death, a debt due to nature, or the puniſhment of ſin, to us is martyrdom, the nobleſt act of Chriſtianity, and ſhorteſt way to everlaſting glory.

Acts v.41.

A discourse, that reliſhed ſo much more of a martyr than of a virgin, gave *Didymus* a riſe to continue a converſation, by which he found himſelf as well aſſiſted as charmed; and therefore obſerving the ſerenity of his miſtreſs's looks to be little inferior to the beauty of her face, and remembering what inſtances ſhe had that day given of an altogether extraordinary piety and courage, was, by the ſentiments theſe reflections produced in him, prompted to tell her; I ſhould be juſtly inconſolable, madam, to ſee myſelf and the world upon the point of being deprived of ſo admirable a perſon, as *Theodora* has, by this day's various trials, manifeſted herſelf to be, if I were not confident, that my loſs will be as ſhort as great; and that, in the ſtate we are now entering upon, I ſhall be allowed what approaching death will deny me in this, and ſhall find in heaven the endearing happineſs of converſing with her more freely, than our perſecutions and her reſervedneſs would here permit. For, madam, (continues he) I am friend enough to my own felicity, to believe aſſuredly, that thoſe, who ſhall be happy enough to meet in heaven, will know one another there, and have their joys heightened by the remembrance of what paſt between them upon earth. For, in the bleſt ſtate we are haſtening to, our faculties, and conſequently our memory, will not only be gratified with ſuitable objects, but be improved by enlarged capacities; and even in a condition ſhort of that we this day expect, men's knowledge has been advanced, at leaſt as much as is neceſſary for our knowing one another, without the helps, that are ordinarily requiſite to make us do ſo. As ſoon as ever *Adam* ſaw *Eve*, he could confidently ſay of her, that *ſhe was bone of his bone, and fleſh of his fleſh*. When *Noah* awaked from his ſleep, he could tell, that during his ſleep, his younger ſon had behaved himſelf irreverently towards him. When our Saviour was transfigured on mount *Tabor*, the three choſen diſciples, that attended him, preſently knew *Moſes* and *Elias*, whom they had never ſeen before, in ſpite of the diſguiſe, that the glory they appeared in put upon them. St. *Paul* tells his Theſſalonians, they ſhall be his joy and crown, before their common Lord: to the truth of which it ſeems requiſite, that both the preachers and the converts ſhall be publickly known at that great appearance, and *aſſembly of the firſt-born, whoſe names are written in heaven*; and conſequently, that men there ſhall know one another. Our divine Redeemer, continues *Didymus*, teaches us, that there is joy in the preſence of the holy angels over a repenting ſinner; which argues, that whether they know of his converſion in a more intuitive way, or by the information of thoſe angels, that are ſometimes ſent to this lower world about human affairs, they yet have a knowledge of particular perſons, and take notice of particular things, that concern them. And, which makes exceedingly for my preſent purpoſe, he introduces *Abraham* in paradiſe, calling upon the uncharitable rich man to remember what his own and *Lazarus*'s differing ſtates had been upon earth: and, which is yet more, to ſhew, that even in the place of utter darkneſs and torment, the memory of paſt things and perſons is not obliterated; the rich man is introduced, as remembering not only *Lazarus*, but his own five brothers, and their dangerous condition.

Matt. xi. 4.
Luke ix. 31.

1 Therſ. ii. 19, 20.

THE pauſe, that *Didymus* made after theſe words, invited *Theodora* to tell him, Since, generous *Didymus*, I have obſerved our ſoundeſt teachers to be of differing opinions about the ſubject of your diſcourſe, and that they do not look upon it as an article of faith, either that the bleſſed do, or that they do not, know one another in heaven; I preſume I may be allowed to think, that if they do, (which I know is the moſt received opinion) they do it in likelihood with other ſentiments, than we commonly imagine. For when the beloved diſciple teaches, that, though *we be here the Children of God, it does not yet appear what we ſhall be*, and adds only in general, that, *when our Saviour*, in that bleſſed ſtate, *ſhall be manifeſted*, we ſhall be like him: when, I ſay, I reflect on this, and ſome things of the ſame import, I am prone to fear, that we judge too much of our future glorious ſtate, by wrong meaſures taken from our preſent frail and mean condition. And I am apt to think, that we muſt ſtay till we come to heaven, before we ſhall frame Ideas ſuitable to the prerogatives of its bleſſed inhabitants. I think our notions will then be raiſed, as well as our duſt, and our love, and other affections, will be transfigured, as well as our bodies. If we know one another, though our mutual love may perhaps be greater than it ever was on earth, yet it will not be upon the former accounts, but will be as well better grounded, as better regulated. That external beauty, purſues the fair ſpeaker, that here is ſo much doted on, and over-valued, will there be found ſo much inferior to that of every glorified body, that the difference and degrees of it will be very inconſiderable, and unable to make differing impreſſions on thoſe, that ſhall remember them: as the refulgent ſplendor of the ſun obſcures all the ſtars, and keeps our eyes from being any more affected by the greateſt and brighteſt, than by any of the reſt: ſo that our kindneſs to one another will be very little grounded upon external qualities, which will there either ceaſe, or be eclipſed; nor upon ſecular relations, which will there affect us far leſs, than our being nearly related to our common Lord; our reſemblance to whom will be the chief, as well as juſteſt ground of our mutual eſteem and affection. When children of the ſame parents have been early parted, and long bred in diſtant places, though, when they are grown men and women, they chance to meet again, it is obſerved, that at firſt they knew not one another any more than mere ſtrangers; and when they are informed of their relation, it is not the little accidents, that happened to them at play, nor ſome features, that perhaps pleaſed one of them in the other's face, but are now very much changed by time and growth, that produce their new kindneſs; but the knowledge, that they are children of the ſame father, and their finding in each other perſonal qualities, fit to adorn their preſent ſtate, and thereby to challenge kindneſs and eſteem. And if ſome years abſence can produce ſo great a change, as to make our neareſt relations unknowable by us, and make us look with pity on the fondneſſes, that trifles produced in us in our infancy; what changes, may we think, muſt be made on thoſe, that converſed together upon earth, when after numerous ages, they ſhall meet in heaven, with minds as much changed and improved, as their bodies will then be? Shall we not, by the grounds of a virtuous complacency, be more affected and united, than we are now by natural relations, or by external beauty, and thoſe other trifles, that here produce the greateſt fondneſſes?

But *Theodora*, (anſwers the ſurprized *Didymus*) can you be ſo rigid as to think, that pure and virtuous affections cannot be admitted into heaven? ſince the ſcripture informs us, that not only joy and deſire are to be found even among the angels, (who are ſaid to rejoice at a ſinner's converſion, and deſire to pry into the myſteries of our religion) but care and actings for oppoſite ends; (as when the angel of *Perſia* withſtood *Michael*, and the angel, that talked to *Daniel*.)

I do not abſolutely deny, *Theodora* replies, that the bleſſed know one another in heaven: and, ſays ſhe, with a light change of colour, I am ſo far inclined to believe it is true, as, for *Didymus*'s ſake, to wiſh it ſo. But, as I lately told you, I am not apt to think, the ſentiments occaſioned by that kuowledge will be ſuch, as moſt men imagine. Beſides thoſe reaſons, that you have ingeniouſly laid together, I think your perſuaſion of the ſaints mutual knowledge the more probable, becauſe it ſeems not readily conceivable, how, at the great day of judgment, the juſtice of God, in rewarding and puniſhing particular virtues and crimes, can be manifeſted to the world, without diſcovering the perſons, by whom they were performed; ſince perſonal circumſtances do very much alter the nature of moral actions. And ſince the happy reſidents in heaven will have an eternity allowed them to converſe with one another in, it ſeems highly probable, that in their various conferences they will meet with, at leaſt ſome time or other, occaſions, that by leſs ſagacity than their enlightened minds will then be endowed with, may be improved to the diſcovery of the perſons they were formerly acquainted with. But on the other ſide, (continues *Theodora*) we ſhall have ſuch noble and charming entertainments to employ our attention, as will engroſs it from the little and deſpicable objects, (as we ſhall then think them) that now amuſe or buſy us; as when we behold ſuch a pompous ſolemnity as a Roman triumph, the variety of ſplendid and magnificent objects, that ſucceſſively preſent themſelves to our view, make us ſo intent upon thoſe ſurprizing ſpectacles, that even the neareſt and deareſt relations, though perhaps gazing at the ſame ſight, out of the ſame windows, are apt to forget one another. And (continues ſhe) even when the ſaints actually know and remember one another, they may love and converſe, upon terms very differing from thoſe, that were ſuitable to their mortal condition. Yes, *Didymus*, (adds ſhe) as there will be no difference of ages and ſexes, in heaven, as there are on earth; ſince all ſhall there be *like the angels*, and have *bodies conformed to the glorious body of their Redeemer*: ſo the rational friendſhips, that will be practiſed in that happy place, will receive their meaſures from the new and perſonal excellencies of their friends; from their being rivals in the love of God; and from their differing degrees of reſemblance to him, that is the *brightneſs of his glory, and the expreſs image of his perſon*. But, concludes *Theodora*, we need not ſpend more time in diſcourſing conjecturally about queſtions, wherein the change we are now going to make, will ſoon bring us to be reſolved. And, in the mean time, we may well reſt ſatisfied with this aſſurance, that ſince heaven is a place, or ſtate, where we ſhall be bleſſed with the *fulneſs of joy*; to know and converſe with each other will be there found, either a part of our felicity, or not neceſſary to it.

CHAP. IX.

WHILST *Didymus* and his excellent miſtreſs ſtood waiting, till the infamous miniſters of the preſident's cruelty had prepared all things requiſite to the execution of his barbarous ſentence; among thoſe many Roman ſoldiers, that were aſſembled there, to be ſpectators of the approaching tragedy, an officer, whom his own gallantry had ſtrongly inclined to ſympathize with a perſon, in whom he ſaw that quality ſo eminent, thought himſelf obliged to attempt the diſſuading him from perſiſting in ſo fatal a reſolution, as he had taken. Wherefore, approaching our martyr, with very obliging looks and geſtures, and drawing him aſide, The gods, ſays he, can bear me witneſs, generous youth, that it is not without ſome amazement, and more trouble, than any affliction of my own has been wont to give me, that I ſee the poſſeſſor of ſo much gallantry upon the point to be deſtroyed by an unhappy conſtancy, which, though in other caſes a virtue, muſt, being exerciſed againſt the gods, become a crime. And therefore, I cannot but ardently wiſh, that after having ſhewn ſo much patience and courage, you would at length expreſs your prudence too, by letting yourſelf be perſuaded to a compliance, that may reſcue you at once from impiety and from death.

An advice, anſwers *Didymus*, that is propoſed with ſo much kindneſs and civility, and yet preſſed but by ſuch unſatisfying reaſons, does juſtly deſerve my thanks for it, but not my compliance with it: for the argument you bring againſt my conſtancy to the truth, is only, that my perſiſting in it will coſt me my life; which is a proof indeed, that the religion I profeſs, will lead me into danger, but none at all, that it has miſled me into error.

It is altogether extrinſic and accidental to a religion's being true or falſe, that its embracers happen to be encouraged by preferments, or expoſed to perſecutions. Fear is but an ill counſellor in matters of religion, unleſs it be the fear of chuſing a bad one, or living unworthy of a good one. He deſerves not the bleſſing of having made a good choice among religions, that does more ſeek, in his choice, the concernments of his life, than of his ſoul. And as it is only for its being the true one, that we ſhould make choice of our religion; ſo, having once choſen it, nothing ſhould make us deſert it, but a conviction of its being erroneous, and conſequently of its wanting that truth, whoſe appearance made us embrace it. If therefore, you can ſhew me, that the Chriſtian religion is falſe, or that yours is better; I am not ſo in love with wandring, as to go on in a wrong way, becauſe I once have, by weakneſs or miſfortune, been miſled into it. But if your arguments be but menaces, or any thing, that is of that ſort, which can only manifeſt, that the power is on your ſide, but do not at all evince, that the truth is not on mine; I muſt look upon what you urge, as not deſerving to be complied with, but contemned. And if it were not my cuſtom never to take any thing ill, that I think is meant well, I ſhould eſteem myſelf not a little injured, by the argument you employ to make me abandon Chriſtianity; ſince, if a perſon leſs civil and gallant had made uſe of it, I ſhould conclude, that he muſt ſuppoſe me a coward, to hope by ſuch perſuaſions to make a proſelyte. And though I were leſs aſſured, than I am, of the truth of the religion I have always owned; yet would I not for all the world, on this occaſion, by profeſſing yours, deſert it; leſt by forſaking it, when I am threatened for ſticking to it, I ſhould procure myſelf a diſquieting temptation to ſuſpect, that I did not deal ſincerely and impartially in chuſing a religion, ſince I made choice of one, that I judged not worthy to be died for.

You miſtake my intentions, generous *Didymus*, replies the Roman, if you think I pretended to fright you into apoſtacy: my virtue would as little allow me to have ſo unworthy a deſign, as your courage would permit a hope, that it ſhould be ſucceſsful. But looking upon myſelf, as having made a right choice in that worſhip of the gods, I make profeſſion of, I could not think it injurious to you to perſuade you, rather to live in the profeſſion of a true religion, than to die for that of a falſe one. And ſince my concern for your ſafety, and the little time you have to deliberate, oblige me to ſpeak freely to you; I cannot but wonder, that a perſon, that hath courted honour at the rate you have done, ſhould loſe himſelf, for one, whom the moſt ſacred perſons of his own nation crucified as a malefactor; and who has been ſo ill-natured, as to invite his followers, both by expreſs words, and by the nature of the religion he framed, which could not but be perſecuted, to involve themſelves with him in the like unhappy fate.

The notions (replies *Didymus*, ſomewhat nettled at this diſcourſe) that idolaters frame to themſelves, of the nature of the Chriſtian religion, are commonly as erroneous, as the ways they take to confute it are improper, and inhuman; and they are uſually no leſs miſinformed about the grounds and myſteries of our religion, than they are miſtaken about the objects of their own adorations. It is true, that the divine perſon I adore, being ſent from God his father to be the great prophet and reformer of the world, did, with a prophetic freedom, as well as authority, ſharply rebuke the ſuperſtitions of the Jewiſh ſcribes and phariſees, among whom he converſed; and did not more unmaſk their hypocriſy, and reproach their practices, by the light of his doctrine, than by the ſhining actions of a moſt exemplary and unblemiſhed life. And his holineſs having exaſperated theſe impious hypocrites, that found their authority undermined, and their perſons diſcredited by him; as their malice was too great, not to attempt the deſtruction of ſuch an enemy, ſo his conſtancy was too great, to ſuffer him to decline the greateſt dangers, by declining to perſiſt in the wonted exerciſe of his virtues; whereby he thus became expoſed to a death, which he foreſaw, and frequently foretold, and which he alſo willingly underwent, to procure everlaſting life for thoſe, who ſhould believe in him, and ſtrive to imitate him.

And that his death, whereunto he ſubmitted to expiate the ſins of others, was not inflicted on him for his own, was evident, by his being abſolved, not only by the very judge, to whom a criminal fear of his accuſers indicted the ſentence he pronounced againſt him, but by that ſupreme and infallible judge, God himſelf; who declared by aſtoniſhing prodigies, both in heaven and earth, how much he was diſpleaſed with thoſe, that put his ſon to death; and by raiſing him from the dead, within three days, to an immortal life, proclaimed, how dear he was to him, and gave him power to make his followers partakers of that glorious condition he himſelf was advanced to. So that (continues *Didymus*) thoſe champions of his, whom he vouchſafes to ſingle out from the reſt of his followers, and call to martyrdom, have reaſon enough to look upon that call, as an invaluable honour, and a privilege; ſince, as they are thereby made more conformable to him, in chearfully dying for truth and conſtancy; ſo they will be made more plentiful ſharers in thoſe ineſtimable advantages, that his own meritorious martyrdom procured him. Yes, for thoſe, to whom he vouchſafes the power and honour of ſuffering for him, and of imitating him, for the intereſt of truth and piety, he does not only reſerve ſuch future recompences, to crown their love and fidelity, but often gives them here ſuch happy foretaſts, in a perfect aſſurance of it, that I cannot but look upon it, as a vaſt acceſſion to that immenſe love, that made him die for us, that he calls and enables us to die for him.

I confess, (*Didymus* adds in purſuit of his diſcourſe) that, as he took upon him the form of a man, ſo he ſuffered himſelf to be uſed as good men too often are. But his miraculous power and goodneſs ſufficiently proclaimed, that he was not thrown down from heaven to earth, as your Vulcan is ſaid to have been; but that he deſcended from heaven, to make men live an heavenly life:

nor did he, like many of your deities, eſpecially your *Jupiter*, aſſume an human ſhape, to do actions below the dignity of human nature; but he taught men a doctrine, worthy, as well as likely, to be brought from heaven; and gave them an exemplary life, whoſe imitation would fit them to be tranſlated thither; and then ſubmitted to the torments and infamy of the croſs, to purchaſe for his followers, by his death, that heavenly condition, for which he had qualified them by his ſpirit and his life.

THE Roman officer, not yet quite diſcouraged by the unſucceſsfulneſs he had hitherto met with in his attempt, reſolved to proſecute it yet further, by ſaying, The ſame reaſon, that ſomewhat leſſens my wonder at your deſpiſing death for your erroneous religion, increaſes my admiration at your unconcernedneſs to avoid the kind of death that threatens your obſtinacy. For though the love of glory may invite a gallant man, like *Didymus*, to part with his life for the attainment of it; yet that ſame heroic paſſion ought to make thoſe it poſſeſſes, more apprehenſive, than others, of thoſe extremities, wherein death is accompanied with infamy, and made juſtly terrible with ignominious circumſtances; of which, none can be more diſgraceful, than the receiving it at the baſe hand of a common executioner.

THE weakneſs and examples of your gods (replies *Didymus*) have too much ſeduced you, to make eſtimates of good and evil by thoſe popular and pitiful meaſures, that I cannot but think very unworthy to be acquieſced in by a Chriſtian; who, to merit that title, muſt be ſomewhat more than an ordinary man. We judge of good and evil actions by the laws of God and right reaſon, not by thoſe of men in power; and therefore do not think, that conſtancy ceaſes to be a virtue, and conſequently an honourable, not a diſgraceful quality, becauſe legal tyrants will call it obſtinacy, and condemn men for it to the ſame puniſhments, that are allotted to diſhonourable actions. The reſpect our religion commands us to pay to a civil magiſtrate, though a perſecutor, permits us not by force to reſiſt his unjuſt ſentences. But this ſubmiſſion of ours does not at all keep his ſentences from being unjuſt, nor forbid us to think them ſo; and conſequently leaves us the ineſtimable ſatisfaction of our conſciences, that inwardly abſolve us, when outward judges condemn us. And for proof of this, you cannot but have taken notice, that, whereas truly criminal perſons, being conſcious of their own guilt, either deny what they are accuſed of, or endeavour by all means to palliate it, and to avoid the being condemned for it; we Chriſtians, on the contrary, do not only confeſs, what you call a crime, but glory in it, and do not deprecate the fate, that attends our conſtancy. Nor can it fright us from undergoing death for a glorious cauſe, that we muſt receive it from an infamous hand. For that, by which we eſtimate it, is, the quality of the action, that procures it, not the condition of him, that is employed to inflict it: and ſo we can conſider with joy, for what, we are not much troubled to ſee, by whom, it is that we ſuffer; being ſatisfied, that the executioner's hand may deſtroy a malefactor, but cannot make one; and if the cauſe, that brings a man to the ſcaffold, be not culpable, the place cannot make the death, that is there ſuffered, infamous: nay, and if virtue leads him thither, the inſtruments of his death cannot keep it from being glorious; ſince this demonſtrates the ſufferer's unſhaken conſtancy to be inſuperable, not only by death, but by that, which many have embraced death to ſhun, the contempt of the generality of men. Your gallant Roman commander, *Attilius Regulus*, is much leſs remembered and celebrated for all his military exploits and attempts, than for the cruel death he ſuffered by order of the Carthaginians, to whom, in performance of a promiſe, he yielded himſelf up, with expectation of ſome ſuch barbarous uſage as he met with. And ſure, as a ſubmiſſion to indignities was a duty not meanly glorious in him, to ſhun the breaking of his word to his enemies; the like reſignation of themſelves, will not, by unbiaſſed judges, be thought an action diſhonourable in Chriſtians, to prevent the violation of their faith ſolemnly given, not to a ſavage enemy, but to a divine friend, who has already, without any obligation to do it, ſuffered more ſhame for them, than the ſublimity of his condition leaves it poſſible for them to ſuffer for him. And though that Greek philoſopher, *Socrates*, whom your own oracles, with more of truth than they are wont to be guilty of, pronounced the wiſeſt of men, was by his own fellow-citizens condemned to die by poiſon brought him by the hand of an executioner: yet ſince that ſentence was not occaſioned by his crimes, but his virtues, the deadly draught did not deſtroy his fame with his life; and poiſoned not his reputation, which it extremely heightned, but that of his accuſers, and his judges; whom after ages have looked upon, as worſe criminals than ever they condemned, and more unworthy perſons, than thoſe they employed to execute their ſentence. And for my part, (continues *Didymus*) ſome paſſages of our ſacred records encourage me to expect, that, if a poſthume fame be ſuch a bleſſing, as many imagine, the indignities we ſuffer now will hereafter procure it us. For I cannot but hope, and methinks I foreſee, that the Roman eagles will one day ſtoop to the croſs of Chriſt; and the temples of your falſe deities will be conſecrated to the ſervice of the true God. The ſword of the civil magiſtrate, which is now the great and only ſucceſsful argument on your ſide, will be then in Chriſtian hands, which I wiſh may never employ it againſt your religion, whoſe ruin will not require the active oppoſition of power, but the bare withdrawing of its preſerving ſupport. And then poſterity, more enlightned and more juſt, will read the hiſtory of thoſe deſtroyers of the baptized (which is, at leaſt, the innocenter) part of mankind, with the ſame reſentments, with which they will read the havocks made by wars, plagues, maſſacres, and other publick calamities.

CHAP. X.

THESE replies of *Didymus* made an end of convincing the perſon, that occaſioned them, that our martyr's reſolution was not to be ſhaken, either by threats or perſuaſions.

BUT yet the officious Roman cheriſhing ſome hope, that if *Didymus* ſhould ſee his miſtreſs ready to be killed by an infamous hand, that beauty, which had conquered his heart, would ſoften it, and thereby make it capable of relenting impreſſions; thought fit to make one addreſs more, and tell him, It is not without extreme regret, that I ſee your inflexible obſtinacy defeat all my endeavours to procure your ſafety. But though your miſtaken gallantry may make you think it unhandſome in a ſoldier, to diſclaim a threatned opinion, that he once adhered to, leſt the change ſhould be imputed to fear or levity; yet I hope you will not think, that the ſtrict rules of that deſtructive gallantry ought to oblige a young lady, in whoſe ſex courage is, at leaſt, an unrequired, if not an altogether improper, virtue: and therefore, I hope you will not refuſe to ſecond my endeavours to perſuade her not to throw herſelf out of a world, of whoſe grandeurs and pleaſures her tranſcendent beauty promiſes her an extraordinary ſhare, as well as her youth fits her to reliſh them perfectly, and enjoy them long.

DIDYMUS, though at firſt ſomewhat ſurprized at this motion, took no long time to return anſwer, by ſaying; I confeſs I cannot partake of the trouble you are pleaſed to expreſs, for the not prevailing of your endeavours to alter my reſolutions; for though the advice you preſſed upon me, was obliging in you to give, yet it would have been criminal for me to take it.

AND as for what you propoſe, in reference to *Theodora*, I muſt deſire to be excuſed from making myſelf acceſſary to your deſign of tempting her: for, in my opinion, he, that ſolicits another to what he believeth a crime, doth become guilty of one; ſo that, as to what concerns *Theodora*, without being at all ſure of ſhaking her virtue, I ſhould moſt certainly ruin my own innocence. Yet I cannot think, (ſays the Roman, interrupting him,) but if you would enforce my perſuaſions with yours, the intereſt you have in her would prevail to make her rather accept of life, than deny a perſon, that ſhe owes ſo much to, and does not leſs highly, than juſtly, value.

IF (replies *Didymus*) I ſhould yield to uſe ſo criminal means, as to give her an example of the apoſtacy you would have me invite her to; the attempt would be leſs improbable: but for me to perſuade her to what I am juſt going to give a convincing proof, that I believe to be worſe than death, would make her both hate me and deſpiſe me. And to convince you, that ſuch a motion as you would have me make, would loſe me all the ſhare I may have in her good opinion, I will dare to own to you, that if I thought her capable, I ſay not of endeavouring to ſeduce me, but of being ſeduced by me, my eſteem of her would alter upon her change. And though I could not deny my wonder to ſo rare a maſter-piece of nature, as is her viſible part; yet there would be a vaſt difference betwixt a meer admiration of external beauty, which muſt become the trophy of age or death, and that high veneration, that I now pay to that admirable perſon's intrinſic worth and unconquerable virtue.

NOR ſhould you doubt (continues *Didymus*) of the entertainment, that ſuch a piety as hers would give ſuch a motion as you would have me make; ſince it would juſtly give her a higher reſentment of my ſolicitations, than of all the importunities of her heathen perſecutors: for theſe do but adviſe her to decline danger, by embracing what they think truth; whereas that, which you would have me to perſuade her to, is to purchaſe her ſafety, by renouncing, what I, as well as ſhe, know to be truth: and I doubt not, that ſuch a proceeding would ſo highly offend her, as to enable her, by a bare pardon, to acquit herſelf of thoſe reſpects and ſervices of mine, to which poſſibly a perſon of her goodneſs vouchſafes ſome title to her gratitude.

THERE is (replies the Roman) ſo great a difference betwixt the caſe of a reſolved ſoldier, that thinks himſelf in point of reputation engaged not to retreat, and that of a young lady, from whom no reſoluteneſs, much leſs obſtinacy, can be expected, that I muſt yet think our joint perſuaſions, though unaſſiſted by your example, would with-hold her from death, now ſhe is near enough to it to ſee the horrors of it.

NAY, (rejoins *Didymus*) I did not ſpeak what I have been ſaying about my own averſeneſs, that I might hinder you from trying your fortune, if you think fit, with *Theodora*'s virtue. I do not envy her conſtancy (whoſe ſucceſſes have been hitherto no fewer than its trials) the honour of gaining more than one victory in one day. But what I have been ſaying, was to give you one reaſon of my refuſing to join with you in your propoſed attempt; againſt which I ſhall now offer this other reaſon, that I think it little leſs than impoſſible it ſhould ſucceed. For I thought I had already ſatisfied you, that as to my intereſt in *Theodora*, if it were much greater, than you, for want of knowing us both, imagine; ſo great a miſ-employment of it, would make me juſtly forfeit it; and perſuaſions, that would ſeduce her to apoſtacy, inſtead of making her follow the advice, would make her but deteſt the adviſer. And as to the hopes you ground on her ſeeing herſelf upon the point of paſſing out of the world; let me tell you, that the ſevere exerciſes, to which her ſtrict piety hath long accuſtomed her, have ſo diſingaged her affections from temporal things, that, being already mortified to the pleaſures and vanities of the world, death can now do no more, but free her from the troubles and perſecutions of it. She hath employed a great part of her life, in preparing herſelf to part with it joyfully, when ever nature and virtue ſhall require it; and ſhe will find it very eaſy to lay it down for religion, now ſhe is in a ſuffering condition, when in her moſt flouriſhing one ſhe found it enough to wean her from the love of the preſent life, that it detained her from the next. Great virtues, ſuch as her's, are like great rivers, which the nearer they come to the ſea, where they are to end their courſe, the greater they are wont to grow, and the more difficult the ſtream is to be withſtood or hindered from its progreſs. *Theodora* now looks upon herſelf, as having but one ſtep more to make, to reach that crown ſhe hath done and ſuffered ſo much for: and that glorious object, viewed at ſo near a diſtance, ſo raviſhes and ſo poſſeſſes her eyes, that ſhe will doubtleſs either not ſee, or not regard, any thing, that would hinder or retard her taking poſſeſſion of it.

HERE the Roman officer, ſomewhat impatient at *Didymus's* diſcourſe, would no longer forbear interrupting it, by telling him; To hear you ſpeak, one would imagine, that you are not talking of a young lady, but of ſome ancient hero, that had been long accuſtomed to deſpiſe the frowns of fortune, and keep himſelf from over-valuing her ſmiles.

HEROICK virtue (replies *Didymus*) does as little know ſexes, as doth the ſoul, wherein it properly reſides. A habitude cannot always be eſſential to the nature of an heroick action; ſince the firſt of that kind, that one does, is not the conſequent, but the beginning, of a habitude: and a ſincere and ſettled reſolution to be highly virtuous may make a woman (as well as a man) to be that, which the nobleſt ſubſequent actions can but declare her to have been. And a perſon, that, like *Theodora*, acts by the aſſiſtance, and as in the preſence, of the deity, may, to maintain her loyalty to God, and her title to the ineſtimable rewards he hath promiſed to perſevering piety, both act and ſuffer greater things, than thoſe very heroes you talk of were put upon, by ſuch barely human motives, as cuſtom, ambition, or revenge. And particularly, as to the point of perſeverance againſt menaces, and proffers; theſe are not like to prevail againſt the conſtancy of Chriſtians much leſs poſſeſſed with divine love and hope, than *Theodora* is. And indeed, there can be nothing upon earth capable to bribe them, to let go the joys of heaven, that ſee themſelves entering upon the poſſeſſion, and find themſelves ſenſible of the ineſtimable value of them.

WHEREFORE (concludes *Didymus*) you will not, I preſume, think it ſtrange, that I refuſe to join with you in a deſign, that I could not ſo much as attempt, either with hope, or without a crime; and that thinking it worthier of my endeavours to imitate *Theodora's* conſtancy, than to ſeduce her from it, I chuſe rather to be a ſharer in the triumphs of her virtue, than a trophy.

CHAP. XI.

THIS reſolute concluſion obliged the Roman officer to break off a converſation, whereby he plainly ſaw there was no cauſe to hope he could ſhake the conſtancy of *Didymus*, and much cauſe to fear, that *Didymus's* conſtancy and diſcourſes would ſtagger many of the heathen auditors. And therefore withdrawing himſelf, much diſcontented at the unſucceſsfulneſs of his perſuaſions, he thought it would be impious to make any interceſſion for perſons he judged invincibly obſtinate, or divert the fatal proceedings of the judge; who, having by this time made an end of thoſe other affairs, whoſe diſpatch *Theodora's* reſpite was not to outlaſt, called for the innocent criminals, and, with a ſtern countenance and voice, demanded, whether they were yet willing to appeaſe the deities they had provoked; and, by burning incenſe to them, endeavour to attone for the affronts they had offered them; adding, that there was now no more time left for deliberating, but that they muſt immediately renounce their impious religion, or ſuffer death for it.

BUT this could not ſhake the illuſtrious priſoners conſtancy, which prompted them to make, with as much haſte as the preſident could deſire, an anſwer, that conſiſted but of a ſhort and reſolute declaration; that they had lived worſhippers of Chriſt, and had a thouſand times rather die, than ceaſe to be, or to profeſs themſelves ſuch; and that for the falſe Gods, the preſident would have them adore, they had rather be their victims, than their ſuppliants, and fall ſacrifices to them, than offer them any.

THIS bold profeſſion ſo incenſed the perſon it was made to, that he immediately gave order, that the priſoners ſhould be led away to the place of execution; and that the miniſters of juſtice, (as he miſnamed his cruelty) ſhould, without delay, go on with the preparations, that were making to deſtroy them. But while theſe officers were ſolicitous to obey thoſe commands, *Theodora* took the opportunity, to tell the generous companion of her ſufferings: It was fit, I confeſs, when we diſcourſed with infidels, to recommend the objects of our hopes, by giving them the glorious titles of crowns and triumphs; ſince being to defend the reaſonableneſs of our conſtancy, by the greatneſs of the rewards we expect for it, it was very proper to repreſent thoſe celeſtial recompences, under the notion of ſuch goods, as thoſe we argued with acknowledged to be the moſt noble and deſirable. But, (continues ſhe) when we ſpeak of Heaven among ourſelves, give me leave to tell you, that I think we ſhould look upon it under a very differing notion; and make a wide diſparity betwixt the Chriſtians paradiſe, and the poets elyſium. The triumphs we ſhould moſt deſire in Heaven, ſhould be, not over our outward enemies, or perſonal ſufferings; but over ſin and ignorance, and the frailties of our natures, and the imperfections of our virtues. And the poſitive bleſſings, that ſhould moſt endear Heaven to us, ſhould be, not ſo much, that we ſhall there be crowned by Chriſt, as that we ſhall live with him, and *follow that ſpotleſs lamb, where ever he goes*; that our gratitude itſelf ſhall be perfect, as well as the bleſſings, that engage it, ſhall be compleat; and that we ſhall have an eternal day to contemplate that ſun of righteouſneſs, without having that glorious object veiled by any interpoſing cloud, much leſs hid from us by the viciſſitudes of day and night. In ſhort, I think, devotion ſhould in our future ſtate aſpire to other things, than thoſe, that may be the objects of meer ambition.

AND now, generous *Didymus*, (adds *Theodora*) ſince we are entering upon the laſt ſcene of our mortal life; let us (I beſeech you) ſummon together and rouſe up all the graces and virtues we have received from heaven, and fervently implore both an encreaſe of them, and a ſupply of any, that our preſent circumſtances require; that we may go off the ſtage piouſly, as well as handſomely, and both act and ſuffer as becomes Chriſtian martyrs. Let not any cruelties or affronts of our inſulting perſecutors be able to diſcompoſe us; but let our evenneſs of mind convince them, that they can as little diſorder us in our way to heaven, as hinder us to get to our journey's end. But let not our undauntedneſs appear the effect of ſullenneſs, or fierceneſs, or of meer reſolvedneſs; but let it be ſo calm and charitable, that we may not be ſuſpected to be the martyrs, rather of our glory, or our courage, than of our religion. Let it not be thought, that we hate life, or deſpiſe it; but only that we think it a cheap purchaſe for heaven, and for the honour of owning and following a redeemer, who, to merit it for us, took the croſs in his way thither.

ADMONITIONS ſo becoming a dying Chriſtian received ſuch an entertainment, as the piety of it, and the veneration he had for the giver, might juſtly challenge from ſo devout and elevated a ſoul, as that of *Didymus*; whoſe reſolute anſwers to the Roman officer, together with his behaviour, as well ſince as before he made them, leaving his enemies no more expectation, that he could be prevailed with, either to alter his own reſolution, or tempt his miſtreſs to change hers; he was appointed to be firſt led away to execution, that the ſight of his blood might terrify *Theodora*, and fright her into a care to preſerve her own. This reſolution of his enemies did not at all leſſen his; but having eaſily obtained leave from the Roman officers, that could not but admire his gallantry, and ſomewhat compaſſionate his condition, to ſay a few words to *Theodora*, he went to that excellent perſon; and approaching her with a far greater reſpect, than he would ſhew to any power, that could but preſerve that life, which the Romans were going to take from him, he told her: Your piety, madam, and your example making me preſume, that, upon ſuch an occaſion as this, I may, with your conſent, part with a life, which, ever ſince I had the fate to ſee you, has been ſo much at your diſpoſal; I am now going without reluctancy to perform that laſt duty, whereto religion calls me. But thinking myſelf obliged to begin with the moſt difficult part of my martyrdom, before I bid farewel to the world, my inclination and reſpect brings me to take my laſt leave of the faireſt and excellenteſt perſon in it. If, madam, (ſo he proceeds) I were in a condition of paying you any further duties, my humble requeſt to you would be, to have the honour of your further commands. But ſince my condition leaves me not a capacity of ſerving you for the future, one of my laſt petitions to you muſt be, to be pleaſed to look upon my paſt ſervices, as extremely ſhort of the deſires of a perſon, that loved you with as much ardency, as your charms themſelves could kindle; and yet with ſo pure a flame, that had it been viſible, even *Theodora*'s virtue could not have diſapproved it. But madam, (continues he) although to reſcue you from the condition you are in, there is no danger ſo deſperate, that I would not joyfully attempt, if I were again at liberty, and though it were poſſible I could ſurvive you; yet I am too much concerned for the nobler part of *Theodora*, to wiſh ſhe would blemiſh ſo ſpotleſs a life to ſave it. Only, madam, give me leave to be ſo kind and charitable to the world, as to wiſh, that providence may find ſome expedient to preſerve for you both your crown and your head; and that you may arrive ſo late at heaven, as to have time to bleſs the earth with a long and exemplary life; and may you lead it with as much tranquillity, as you will with virtue; and without knowing ſo much as that trouble, which, I fear, your generous compaſſion may now and then offer to give you, upon the remembrance of the faithfulleſt of your ſervants.

THESE words, and the ſad occaſion of them, having drawn ſome tears into *Theodora*'s fair eyes; though the cauſe of them made them very obliging to *Didymus*, yet his concern for her quiet preſently engaged him to help her to ſuppreſs them, by making haſte to tell her, that it was pity the ſerenity of her mind and looks, which virtue had ſtill kept calm, and even perſecutions had not been able to diſorder, ſhould be diſcompoſed by any other thing. And madam, (continues he) though being confident, that your charity will make it unneceſſary for me to beg your prayers, I was going to make it my petition to you, that you would vouchſafe now and then to caſt a thought on the memory of a perſon, to whoſe mind you were conſtantly preſent; yet I muſt now retract that humble requeſt, unleſs you are pleaſed to grant it me with this qualification; that the honour you do me, may not be diſquieting to you. For how great a bleſſing ſoever it is, to enjoy a place in your thoughts; yet an idea muſt repreſent quite another man than *Didymus*, that ſhould, eſpecially on its own ſcore, become troubleſome to *Theodora*, whoſe compaſſion is as well needleſs, as undeſired; ſince it is injurious both to herſelf and me, to look upon him as a perſon to be pitied, that is going to receive the honour and ſatisfaction to ſuffer in her ſight, what he ſuffers partly for her ſervice. And the place he implores but in her favourable, not her mournful thoughts, will give him the nobleſt and deſirableſt being, that he can have upon earth, when he ſhall be in heaven.

THE things, which *Didymus* ſaid, and the pathetical way he ſaid them in, did not leave the fair perſon, they were addreſſed to, all the unmovedneſs of mind ſhe uſed to be miſtreſs of on other occaſions. And conſidering theſe as the laſt and dying words of an accompliſhed gentleman, that had ſo highly ſerved and loved her, ſhe could not hinder her reſentments from making her, on ſuch an occaſion, remit ſomewhat of her wonted reſervedneſs. Wherefore with eyes, wherein though ſhe endeavoured to ſuppreſs tears, ſhe diſcloſed an extraordinary grief; and with looks, wherein both gratitude and obligedneſs diſplayed themſelves, ſhe told him, If I looked upon your virtue, generous *Didymus*, as one, that were but ſomewhat extraordinary, I ſhould think myſelf obliged to make excuſes, and ſeek your pardon for having been, though undeſignedly, ſo acceſſary to the early loſs of a life ſo worthy to be a long one: but what you have this day done, makes me apprehend, that ſuch diſcourſes would not be very pleaſing to one, that delights in ſuch actions. But do not think, I conjure you, that though I cannot pretend to merit or requite ſervices of ſo unuſual a ſtrain as yours, I can be inſenſible, how much I owe to them, not only upon the ſcore of their greatneſs, but upon that of the handſome and generous way, wherein you did them. For (continues ſhe, with a colour, that ſomewhat expounded the meaning of what ſhe was going to ſay) if after the virtue and gallantry you this day expreſſed, providence had thought fit to place me in a condition of making you retributions, I will allow you to think, that, in chuſing them for you, I ſhould have been very much, if not unreſervedly, guided by your wiſhes. Here ſhe pauſed a while, and bluſhed; the latter, that ſhe had ſaid, what to her niceneſs ſeemed ſo much; and the former, to conſider, whether he deſerved not to have more ſaid to him. But her obliging looks did ſo well ſecond and expound her otherwiſe ſomewhat indefinite words, that *Didymus*'s heart readily underſtood the language of her eyes; and her heart ſpoke ſo clearly in her cheeks ſomewhat, that it ſcrupled to utter by her tongue, that, expreſſing more than ſhe ſaid, without injuring her modeſty ſhe righted her gratitude; her paſſionate admirer eſteeming himſelf more highly recompenced by this permiſſion to ſuppoſe her kindneſs, than he would have done by the perfecteſt aſſurance of any other's love; and fancying, that by the ſight of that new fire, that flaſhed in her cheeks, he could diſcern in her breaſt ſuch a reſentment of his ſervices, as involved an approbation of their cauſe, and implied a peculiarity for his perſon; he took the higheſt retribution he ever did, for the higheſt he ever could receive from a lady, whoſe beauty and reſervedneſs were ſo great, that no favour of her granting could appear little.

BUT *Theodora* quickly recovering the diſorder this merited declaration had put her into, made haſte to proſecute her diſcourſe, by adding, but it is my ſatisfaction, and will, I hope, be yours, that ſince you acted upon religion's ſcore, as well as mine, you will not want a recompence, greater than it had been poſſible for me to give you; ſince in reſcuing me upon a Chriſtian account, you have ſerved a maſter, that is able moſt richly to reward, even your performances and ſufferings. And doubt not *Didymus*, (continues ſhe) but that, when you ſhall once be poſſeſſed of a glorious and immortal crown in heaven, you will have no cauſe to be troubled at your having, upon earth, left a crown of lawrel, or miſſed one of myrtle. If I were to tarry, or rather languiſh, here below, as many years as your miſtaken kindneſs makes you wiſh me; your favours have been ſo extraordinary, that, without being guilty of an ingratitude, that would be ſo too, I could never loſe the remembrance of them, nor omit paying you the higheſt acknowledgements, that the chief place, not only in my memory, but in my eſteem and friendſhip, could make you. But do not, *Didymus*, I beſeech you, think of my ſurviving you, when the holding out a few minutes longer for Chriſt will introduce me into a condition, where I ſhall ever ſee him, and never offend him. Let us then (concludes ſhe) quit the thoughts of this world, that we are going ſo ſoon to quit, and begin to fix them on thoſe joys of another, that we are going to poſſeſs for ever; and during that little time, that is requiſite to go take our crowns, let us ſummon up all our powers, to contribute to a behaviour befitting ſuch expectations. Let our laſt ſervices to religion be our nobleſt ones, that our deaths may at leaſt adorn it, if not propagate it. Let us receive the laſt effects of our perſecution, as perſons, that do not deſerve ſuch an uſage, and are above the reach of it. Let us aſpire to Chriſt's temper in his cauſe;

and ſuffer like him, as we ſuffer for him: and then we need not doubt, but in ſpight of this ſhort ſeparation we are yielding to for his ſake, we ſhall joyfully, and for ever, meet again in a better place, and in an ineſtimably happier condition.

Theodora had ſcarce made an end of ſpeaking, when all things being in a readineſs to put the judge's ſentence in execution, they, to whom that infamous employment was committed, came to bring notice of it to *Didymus*; who, notwithſtanding the reluctancy he had to part with the admirable, and now obliging, *Theodora*, thinking it would miſbecome him to ſtay for being preſſed on ſuch an occaſion, delayed not, with all the reſolution he was able to aſſume, to take his laſt farewel of her. This cruel ſeparation being not to have an end before both their lives, was ſolemnized by that excellent pair with geſtures and expreſſions ſo ſenſible and moving, that declining an account, which I could not attempt to give, without ſharing very much in a grief, that I ſhould be able, but very imperfectly, to deſcribe; I ſhall ſilently paſs over the circumſtances of this ſad ſeparation, that more troubled the generous lover, and perhaps his admirable miſtreſs too, than that of ſoul and body, which was preſently to follow it. But *Didymus*, now finally parted from *Theodora*, whilſt he was moving towards the place of his ſufferings, did, by the aſſiſtance of him, whoſe religion called him to them, aſſume a temper of mind ſuitable to the glorious work he was going to undertake, and entirely diſpoſed himſelf, after having done all, that became a lover, to ſuffer as became a Chriſtian.

THIS was much the leſs difficult for him to do, becauſe his whole paſt life was an excellent preparative to make him act the laſt ſcene of it worthily. For (to add ſomewhat on this occaſion, to the character given of him in the firſt book,) *Didymus* was a perſon, in whom divine grace had produced ſo early a piety, that he was a well grown Chriſtian, before he was come to be a full grown man. And judging the moſt flouriſhing time of his age to be, for that reaſon, the fitteſt to be devoted to the moſt worthy of objects; he was enabled both to ſuppreſs the heats of youth, and deſpiſe the vanities of the world, even while that uſually ungoverned age made the former moſt impetuous, and gave the latter the great endearment of novelty. Nor did his being a ſoldier prove an obſtacle to his piety. The examples of *Joſhua*, *David*, *Jonathan*, and other brave warriors of the old teſtament, ſhew, that heroick valour may be accompanied with eminent piety. And the firſt proſelyte the heathen world preſented to Chriſtianity, being a captain, and continuing to be ſo after his converſion, argues, that a military ſtate of life is not inconſiſtent with the moſt innocent of religions. And for *Didymus*, as he fought not out of fierceneſs, or avarice, or ambition, but to exerciſe and improve his virtue; ſo amidſt all his military conflicts he was ſtill careful *to fight the good fight of faith*: and being taught by the holy ſcripture, that *the life of man here on earth is a kind of military one*, he uſed the Roman camp as a ſchool to a higher ſort of warfare; where, as the hardſhips are greater, and the victories more difficult, ſo the crowns and triumphs are incomparably more valuable and glorious. A perſon thus qualified and diſpoſed could not find it very uneaſy to part, for his religion, with a life, that he had led ſo well, and hazarded ſo often; nor to leave a world, that ſin and perſecutions embittered, and that was preſently to be left by *Theodora*, that he might paſs to a place, where they ſhould meet to be crowned. Wherefore, reſolving to ſhew, that the approach of a reputedly infamous death was not able, either to ſhake his conſtancy, or extinguiſh his charity; he diſpoſed himſelf to mingle in his laſt actions and ſufferings the courage of a Roman ſoldier, with the reſignment of a Chriſtian martyr. And accordingly, walking on towards the place of execution with a calmneſs and undauntedneſs, that could ſcarce have proceeded from a reſolution not ſtrengthened by faith; as ſoon as he came thither, he looked round about him upon the guards, and other aſſiſtants of this ſad ſpectacle, in ſuch a way, as if he rather pitied them, than liked the pity, which many of them could not but by their tears expreſs for him, and diſcourſed to them with all the graceſulneſs, that youth and courage could give ſo extraordinary a perſon. And becauſe he ſuppoſed, that (as it was uſual on ſuch occaſions of concourſe) there were among the ſpectators ſome military men, that were Chriſtians in their hearts, though they had not been called to own it publickly; he addreſſed himſelf particularly to them. And having premiſed, that he pretended not to inſtruct them as barely Chriſtians, becauſe he doubted not, but he had been prevented by the weighty and moving ſermons of divers burning and ſhining lights, and guiders of the church; he told them he would confine his advices to what was ſuitable to the condition he ſhared in with them, of being Chriſtian ſoldiers. And then he briefly, but pathetically, exhorted them to all thoſe virtues and practices, that might recommend both their perſons, their profeſſion, and their religion: the laſt of which, by many arguments, (which his example made the more impreſſive) he perſuaded them, after having adorned it by their lives, to confirm, if they were called to it, by their deaths; without forgetting, that the fearful are by the ſcripture ranked with the *unbelievers*, as deſtined to the ſame place of torment; and without fearing any unmerited diſgrace, ſo much as that deſerved one, threatned by the captain of their ſalvation to thoſe, that *ſhall deny him before men*. He exhorted them, by their courage and obſequiouſneſs to convince their unbelieving ſuperiors, that the valour of Chriſtians could be eminently active, when their religion did not confine it to be paſſive; and that when enterprizes

Rev. xxi. 8.

Heb. xi. 10.

enterprizes, how dangerous ſoever, were as juſt and noble as difficult, they could emulate, if not outſhine, the gallantry of thoſe deified heroes they refuſed to worſhip. And laſtly, having preſſed them to be loyal to the Emperor, and obedient too, as far as was conſiſtent with fidelity to him, that made him ſo; he begged their prayers for himſelf, and put up ardent ones of his own, for the church, the ſtate, his perſecutors, and, particularly, for the excellent companion of his martyrdom. This ſaid, he began to do what was to be done by him, towards the deliverance of his ſoul from his body; and having done it with ſo much ſerenity of mind and looks, that he extorted an eſteem of his virtue, even from thoſe, that deſtroyed him for it; he let the executioner do his part too, (which probably was done by taking off his head) and in a moment paſſed from being a ſuffering member of the church militant, to be a happy one of the church triumphant.

CHAP. XII.

THE perſecutors of *Theodora* hoping to intimidate her by ſo tragick a ſpectacle, had conducted her to a place, whence ſhe might ſee all, that had paſſed; of which it will eaſily be believed, that ſhe had not been an unconcerned ſpectator: her virtue and kindneſs making her a ſharer in his ſufferings, by ſympathiſing with him, and by endeavouring, as far as ſhe could, to relieve him by her moſt ardent prayers; that his conſtancy under them might be divinely ſupported, and richly crowned. But while her thoughts were, with a divine grief, ſolemnizing her loſs, thoſe cruel men, that had procured it, being deſirous to make uſe of the terrifying impreſſions they ſuppoſed ſhe had received, while they were freſh and recent, advanced to *Theodora*, bringing with them the purpoſely disfigured remains of *Didymus*; and then told her, that ſhe was now convinced, that neither youth nor gallantry was able to protect from the fatal anger of the Gods thoſe, that obſtinately refuſed to worſhip them; and therefore they expected, that, by a ſeaſonable care of herſelf, ſhe would ſhun the imitation of ſo tragical an example. To this the fair martyr replied, that ſhe was not at all ſurprized at what had paſſed, and therefore ſhe knew not, why ſhe ſhould be terrified by it. For *Didymus* and ſhe, and all other conſidering Chriſtians, that walk according to their maſter's directions, were wont deliberately to weigh the conſequences of embracing a ſtrict and perſecuted religion, before they made profeſſion of it: and having foreſeen what it might coſt them, and ſatisfied themſelves, that it deſerved a yet higher price, they were not diſcouraged nor ſurprized to be put to pay that price; eſpecially, when it opened to them an immediate paſſage to the poſſeſſion of what they gave it for. She added, that if the example of the generous martyr were to have any operation upon her, it ought not to fright her from, but confirm her in, the profeſſion of a religion, whoſe truth he thought worth dying for; and which, notwithſtanding all the handſome concerns he had for her preſervation, he would never ſpeak one word to perſuade her to decline, for the protracting of her life. His example (continues *Theodora*) lets me ſee, that no violences upon earth are able to deſtroy a courage, that is aſſiſted from heaven, and fights in view of the glories of it; and his death manifeſts, how quick the paſſage may be between this and an incomparably better life; and clearly ſhews, how ſoon the utmoſt effect of your cruelty can place thoſe, that deſpiſe it, above the reach of it. Then caſting her mournful eyes upon the ſaddeſt object, that ever they beheld; If you ſhould, ſays ſhe, be ſo inhuman, as to exerciſe any further cruelty upon this now inanimate priſon, whence his glad ſoul has eſcaped, you may intend him a miſchief, but he will not feel it, unleſs it be in the encreaſe of the recompences of his martyrdom. You may, if you pleaſe, inſult over his dead body, and thoſe, whom his virtue made his friends, may ſome of them be troubled at it; but while you are triumphing at his death, and others are deploring it, I doubt not, but the welcomes and joys he receives in the bleſſed place he is gone to, make him happy enough to pity not only thoſe, that hate him, but thoſe, that pity him too. What you ſhew me, as the trophy of your power, I look upon, as that of his conſtancy; and for what you preſume to be your victory, he will be really crowned. The grave, (continues ſhe) is, I confeſs, a ſad proſpect to them, that look no further, and terminate their ſight there; but not to thoſe ſufferers for the truth, who, with the eye of faith, looking beyond it, ſee all thoſe glories on the other ſide of it, that expect them there; whereunto as ſome kind of death muſt neceſſarily be the way, ſo martyrdom of all other is the nobleſt. Wherefore, (concludes *Theodora*) you will very much miſs your aim, if you forbear bringing my conſtancy to the laſt trial, only upon hopes, that death dreſſed with unuſual horror, by being beſmeared with *Didymus*'s blood, ſhould frighten me into apoſtacy; for I am much leſs terrified by his fate, than encouraged by his example: in imitation of which, I declare to you once for all, that, as I always valued this world too little, to be much afraid to part with it for a better; ſo I ſhall never be brought to quit an excellent religion for a bad one, for fear of exchanging a wretched life for a happy one.

THIS poſitive and final declaration of *Theodora* did ſo enrage thoſe, to whom ſhe made it, that finding themſelves quite diſappointed of the hopes they had to terrify her by their laſt expedient, *Didymus*'s death, they preſently led her away to participate of his fate, which they found her reſolved not to decline.

And now the admirable *Theodora*, having received that cruel, but welcome command, moſt readily diſpoſed herſelf to obey it: and conſidering, how near ſhe was to put a period to all the afflictions of her life, by the glorioueſt action it could be concluded with, and how ſoon ſhe ſhould enjoy the happineſs of entering heaven, thorough the ſtreighteſt and nobleſt gate, at which it is acceſſible; her beauty, that was before admirable, appeared more ſo than ever, being ſtrangely increaſed by the effuſions of a cœleſtial joy, that did too much abound in her heart, not to flaſh out manifeſtly in her looks, to whoſe native charms it ſuperadded ſo much luſtre and majeſty, that ſhe ſeemed (upon ſome peculiar deſign) to be newly come from the heaven ſhe was going to. So great a conſtancy and chearfulneſs of mind, upon ſo ſad an occaſion, wanted not a reſembling operation upon the generality of the wondering aſſiſtants: for though the report, that was quickly ſpread of ſo uncommon an action, as that of *Theodora*, done by ſo extraordinary a perſon, as fame had repreſented her to be, had drawn a great concourſe of people, to ſee one, that acted, as well as looked ſo handſomly; yet when they had a while beheld her, and ſaw the cruel inſtruments of what ſhe was doomed to ſuffer; among that numerous throng of ſpectators there were none, that were not admirers; many, that looked on her with dazled, and few without flowing eyes; every ſort of ſpectators found ſomething in her perſon and condition, that made them mournful ones. The Chriſtians, that chanced to mingle with the reſt of the crowd, lamented to ſee their religion deprived of ſo great an ornament, and ſo ſhining an example; though their grief were moderated by conſidering, that ſhe was entering into a moſt happy place, to which they might hope, e’er long, to follow her. And, in the mean time, it was no ſmall credit to their religion, that a lady of her beauty had lived according to the ſtricteſt laws of it; and a perſon of her youth and ſex was ambitious to die for it. Thoſe among the ſpectators, that yet retained Roman ſpirits, and were the genuine off-ſpring of thoſe noble anceſtors, that ſcrupled not in *Rome* itſelf, to allow public marks of honour to its greateſt enemies, could not but be troubled, to ſee ſo rare a thing as a female hero puniſhed for a generoſity, that could not ſufficiently be rewarded, and brought to an untimely, and, in popular eſtimation, ignominious end, for having followed dictates of gratitude and piety. Thoſe infidels, on whoſe ſentiments virtue had more influence than ſuperſtition, were very much diſſatisfied with the rigour of their magiſtrates; thought it a diſcredit to their religion, to uſe ſuch barbarous, and yet ineffectual courſes, to fright men into it; and they thought it an invidious ſervice to their gods, to deſtroy the faireſt maſter-pieces they had made. But thoſe, that ſeemed moſt to deplore the fair martyr’s condition, were thoſe, that were diſpoſed to have their affections wrought on by their eyes, and were apt to be influenced by beauty: for theſe much repined and grieved to ſee ſo glorious a ſun reduced to ſet in her eaſt; they envied *Didymus*, for having ſo generouſly ſerved and ſuffered for ſo rare a perſon, who, they thought, inſtead of the barbarous uſage ſhe received, deſerved to be as happy, as her ſmiles could make her adorers; and they allowed themſelves to think, that nothing could be a virtue, that deprived the world of ſo much beauty. In ſhort, moſt of the by-ſtanders grieved, to behold a perſon, whoſe youth would paſs for innocency, and whoſe charms would give her captives among ſavages, deſtroyed in *Greece*, by Romans. So that bating thoſe few barbarians, whoſe ſuperſtition and malice brought her to that condition, all the other ſpectators of her ſufferings were deplorers of them too; and many to that degree, that, to judge by their looks, and thoſe of our fair martyr, one would have believed, that the aſſiſtants were to be ſufferers in the approaching tragedy, and ſhe but the ſpectator of it.

AND now the matchleſs *Theodora* came to the place, whence her aſpiring ſoul was to take its flight to heaven. In order to which, ſhe firſt looked about her, with a kind of pity, on thoſe, that either never, or later than ſhe, were to be admitted into the felicity ſhe was preſently to poſſeſs: and afterwards ſhe pauſed a while, to recover from ſome diſorder, that ſhe was put into; not ſo much to ſee herſelf environed with guards, as ſurrounded with gazers. And then, though her baſhfulneſs made it more uneaſy to her to ſpeak to the aſſiſtants, becauſe her ſpeech muſt be a public one, than becauſe it muſt be her laſt; yet with a voice and geſtures, wherein the modeſty of a virgin, and the courage of a martyr, were happily tempered, ſhe addreſſed herſelf to thoſe, that were about her, in ſuch as the following terms:

SINCE cuſtom has made it a kind of duty, that thoſe, that come to this place, ſhould ſay ſomething to the ſpectators, and make a public confeſſion of their guilt, or proteſtation of their innocence; I ſhall, in part, do both the one and the other; for I will not deny, that I am, what the laws have condemned me for being. Yes, I own myſelf a Chriſtian, and in ſpight of all my paſt and approaching ſufferings, I declare, that I think it an honour and a happineſs to be ſo: but, on the other ſide, I can moſt truly proteſt, that I have tranſgreſſed no other Roman laws, than thoſe, that are repugnant to thoſe of God and reaſon. And ſince we Chriſtians are taught by our great Maſter’s example, as well as precepts, not only to forgive, but to love our enemies, and pray for our perſecutors; I think myſelf obliged, and, by his aſſiſtance, find myſelf enabled, not only to forgive, as I heartily do, the procurers of my death, but ardently to implore for them the bleſſing, and the unmoleſted exerciſe of a religion, that they ſee I value more than I do my life. And I hope, thoſe in authority will, by the frequent executions, that daily ſucceed one another in this place, be at length convinced, how ineffectual, as well as inhuman, a way they take to extirpate Chriſtianity; which being an heavenly light, can be as little ruined by the violence employed againſt it on earth, as tempeſts can extinguiſh the ſun. And becauſe it is likely, that charity or curioſity has, among other ſpectators, brought hither ſome Chriſtians, I ſhall now addreſs myſelf to them; yet not to deſire their pity, but their prayers, that I may be enabled to overcome the laſt enemy, death, and finiſh my courſe in ſuch a way, as may neither blemiſh my paſt life, nor the glorious cauſe I gladly loſe it for. But the chief part of my requeſt regards yourſelves, not me: for I muſt beg you to remember, that, beſides an All-ſeeing-eye, there are many eyes upon you, that pry into your actions with ſtrong deſires to find them criminal; and that though the truth, nor the ſubſiſtence of Chriſtianity does not, yet the credit of it does much depend upon the nature of your actions. For as all your perſonal faults will be imputed to your religion; ſo your ſhining virtues will probably bring many infidels, firſt to admire, and then to embrace Chriſtianity; juſtly concluding, that that religion muſt be excellent, that makes its profeſſors ſo, and enables, as well as enjoins them, to live blameleſs in the world, and go joyfully out of it. If you lead ſuch lives, you will not be much afraid of martydom, which will but ſend you ſooner to receive thoſe ineſtimable rewards of them, that God's goodneſs hath promiſed and provided. I wiſh you may never have cauſe, nor, upon occaſion, want courage, to enter into life at that ſtreight gate, that I am now going to paſs through. But if you be called to that way of glorifying God, let neither the ignomy, nor the painfulneſs of it deter you. It is not ſhameful, but glorious, to ſuffer for God, for truth, and for a crown; and my example may encourage the weakeſt of you to expect, that *God's ſtrength will be made manifeſt in your infirmity*; and that there is no temptation but may be reſiſted and vanquiſhed by the weakeſt hand, that is ſupported and ſtrengthened by an almighty arm. And though the diſtance between heaven and earth, our mortal and our immortal ſtate, be very great, yet the paſſage between them may be very ſhort; and a few moments may bring us to exchange our agonies for extaſies, and paſs from the lamentations of our friends, and the reproaches of our perſecutors, to the congratulations of angels, and the ſolemn welcomes of him, whom even thoſe heavenly ſpirits adore.

As ſoon as ſhe had ended this diſcourſe, though her ſoul, abandoning ſuch a body as her's, could ſcarce any where, but in heaven, find an advantage by a change of manſion, yet it cheerfully diſpoſed itſelf to a ſeparation, that would give it a cloſer and more immediate union with the divine object of its cœleſtial love. And after ſhe had decently and calmly made all the preparation, that on her part was requiſite for what ſhe was to ſuffer, ſhe thought fit to make her life's laſt actions, as moſt of the reſt had been, acts of piety and charity. And therefore elevating her eyes and hands towards heaven, where her heart, as well as her treaſure, had been placed long before, ſhe firſt paid her God moſt humble thanks, for the grace and opportunity he had vouchſafed her, *not only to believe in his divine Son, but to ſuffer for him*; and then made a ſhort, but very fervent prayer, for the church, for her enemies, and for herſelf. Which done, with a countenance, wherein ſerenity was mingled with joy, ſhe gave a ſign to the executioner to do his office, who thereupon did all that was neceſſary to complete her martyrdom. And the glad ſoul was by the angels, (whom ſhe had aſpired to reſemble in purity and devotion) carried to that happy place, whoſe glories are neither to be conceived by thoſe, 1 Cor. xi. 9. that have not ſeen them, nor deſcribed by thoſe, that have; 2 Cor. xii. 4. ſuch ſupernatural felicities as much tranſcending man's ideas and his expreſſions, as they ſurpaſs his merit.

MEDICINAL

MEDICINAL EXPERIMENTS:

OR, A

COLLECTION

Of CHOICE and SAFE

REMEDIES

For the moſt PART

SIMPLE, and eaſily prepared: Very uſeful in
FAMILIES, and fitted for the Service of
COUNTRY PEOPLE.

The PREFACE to his RECEIPTS ſent to a FRIEND in *America*, in the Edition printed at London in 1688, and omitted in the ſubſequent ones.

The INTRODUCTION.

THE following preſcriptions being but part of a collection of receipts and proceſſes, that had from time to time been recommended to me, either by the experience of the imparters, or by my own; I did not think it ſo expedient to promiſe, to ſo ſmall a number of ſlight receipts, the ſeveral medicinal cautions and other conſiderations, wherewith it might be fit to uſher in a larger writing of this nature, as to reſerve thoſe prolegomena for the whole collection, whereof that, which now appears, makes but a part, and that not the greateſt. Which intimation will, I hope, excuſe my leaving unmentioned the names of the imparters of ſeveral of theſe receipts; ſince all of them are tranſcribed from the collection; and the reaſon of the omiſſion is given in the preamble, together with divers advertiſements about the work itſelf, which diſpenſe me from giving any others at preſent, than thoſe very few, which ſeemed requiſite to be ſent about the following paper, to the inquiſitive Dr. *W. A.* practiſing phyſic in *New England*; who earneſtly deſired of me ſome receipts, that, being parable or cheap, might eaſily be made ſerviceable, eſpecially to the poor, in that country; where European books of phyſic are too great rarities, and ſeveral remedies, here known, are not in uſe.

THE beginning of my letter to Dr. *A.* conſiſting mainly of things, that regarded his peculiar circumſtances, it is needleſs, if not improper, to tranſcribe it hither, and conſequently it ought not to keep me from proceeding, without delay, to the next part of my letter, which gives him the three following

ADVERTISEMENTS.

I. IT would be a great miſtake of my deſign, in ſending you the following receipts, if you ſhould think, that I at all pretend them to be infallible ones, or at leaſt of very extraordinary efficacy; ſince all, that I told you of them, was, that, for medicines ſo ſimple, and for the moſt part ſo cheap, I have found ſeveral of them, and take all of them, to be good in their kind. And though I think moſt of them ſafer than many other medicines, that are in great requeſt, yet I do not pretend, that theſe ſhould play the part both of medicines and phyſicians too; but only that they may be uſefully employed by one, that, like you, knows how to adminiſter them diſcreetly. In ſhort, I ſay not, that theſe medicines are the beſt I have, but only ſome of the moſt parable, or ſimple; both which I here mention together, as if the latter were referrible to the former; not only becauſe medicines, that are ſimple, or but very little compounded, are, *cæteris paribus*, more eaſy to be procured, but becauſe I am willing, that this ſhort collection ſhould furniſh you with divers inſtances to confirm the paper, to which I deſire you would ſubjoin it, of the uſefulneſs of ſimple medicines.

II. It may ſomewhat aſſiſt you to make a comparative eſtimate of the following receipts, if I diſtinguiſh them into three claſſes or orders, and annex to the title, or deſcription, of almoſt each particular medicine, one of the three firſt letters of the alphabet. Whereof *A* ſignifies, that the remedy it belongs to hath been, either by the affirmation of the phyſician, or other credible perſons, that imparted it to me, or by trials, that I cauſed to be made of it, recommended as very conſiderable and efficacious in its kind. *A* therefore is the mark of a remedy of the higheſt claſſis of theſe. *B* denotes, that that, which it refers to, is of a ſecond or inferior ſort, but yet conſiderable for its good operations. And the letter *C* belongs to thoſe remedies, that are of the loweſt order, though good enough not to be deſpiſed.

And becauſe I preſume it may be expected, that I ſhould give you ſome ſhort character, of thoſe, whereof I have had ſome kind of experience, whether by the relation of ſuch as have been cured or much relieved by them, or by my own exhibiting or preſcribing them; or by reports received from thoſe, that engaged to try them, or that employed them upon my account: for this reaſon, I ſay, and for brevity's ſake, and avoiding repetitions, I thought fit to accompany almoſt each of the three forementioned alphabetical letters, that refers to a receipt, of which I can ſay any thing upon ſome kind of knowledge of my own, with one of the three following marks: whereof the firſt, which is the ſmall figure of (1) denotes, that I have known but a ſingle trial of it; the other, which is a ſimple croſs (+) imports, that the trials have been made two, or ſome few more times; and the third, which is an aſteriſk (conſiſting of ſeveral lines croſſing each other in one point (*) ſignifies, that the trials, wherein it hath been found uſeful, were many, if not very many.

III. There will be eaſily obſerved a diſparity of ſtyle in the following papers; for thoſe receipts, that were my own, were expreſſed in my own terms; and ſo uſually were thoſe, that I received from others but by word of mouth; and theſe, I hope, will be found clearly enough delivered: but as to thoſe others, that were imparted to me by empiricks, or unlearned perſons, in writing; though I would not, in divers places, have worded them as they did, that I had them from, yet I oftentimes made a ſcruple to correct or alter their expreſſions, though not ſuitable to the current ſtyle of the formularies of receipts; being more concerned, that the meanings ſhould be cloſe kept to, than the ſtyle rectified. And ſometimes too, when I received things by word of mouth, and committed them to paper in the author's preſence, haſte obliged me to make uſe of expreſſions, (and made me afterwards forget to mend them) that were rather the ſhorteſt than the beſt; and ſometimes forced me to employ words of the Latin, French, or ſome other language, eſpecially if I wrote after the inſtructions of foreigners; being leſs careful to expreſs things in the fitteſt way I could, than in the moſt compendious.

You will receive, by this ſhip, but five decades of receipts of parable medicines, becauſe I think that number ſufficient to be ſent at once. But if, when you have tried them, the ſucceſs, that God ſhall vouchſafe to give them, ſhall invite you to preſs for a recruit, I ſhall thereby be encouraged to draw ſome other decades of receipts (ſome of which will perhaps be preferable to moſt of theſe) out of a collection, wherein they have long lain mingled with receipts and proceſſes of remedies of a leſs ſimple nature, or more difficult to be procured.

The PUBLISHER to the READER.

These receipts, taken out of a large collection, as conſiſting of a few ſafe ingredients, commonly to be found at eaſy rates in moſt places, were ſent to a learned phyſician beyond-ſea; to whom they were a welcome preſent, and anſwered, without doubt, the ends he had in deſiring them.

That excellent perſon, to whom theſe choice preſcriptions are owing, did permit a few copies of them to be printed, and was pleaſed to put them in the hands of ſome of his friends, provided, as there was occaſion, they would make trial of them, and faithfully report the ſucceſs.

Divers of thoſe, who, on theſe conditions, had received ſo great a favour, held themſelves obliged to inquire for perſons affected with any of the maladies againſt which the ſaid medicines were preſcribed; and, upon many experiments carefully made, having found, that frequently they have relieved thoſe, who uſed them, and ſometimes ſtrangely out-done expectation; they addreſſed themſelves with much importunity to the noble author, to ſuffer things, which were of ſuch general benefit, and ſo eaſily to be procured by the poor, to be made more publick.

And at length he hath been prevailed with, not only to allow the former receipts, which but few had ſeen, to be reprinted; but hath, out of his rich treaſury, ſtored us with a freſh collection, which, as in number it exceeds what we had before, ſo in quality and virtue it falls not ſhort of it.

And if what here with ſuch an honeſt and kind deſign is offered to the public, be but candidly and favourably received, we may ſtill hope for more bleſſings of this ſort from him, who has not only a conſtant will and great abilities to do good, but hath, perhaps, obliged the age as much as any private perſon in it.

The AUTHOR's PREFACE.

Though phyſic be not my profeſſion, yet I hope this ſmall collection of receipts will not incur the cenſure of equitable and charitable perſons, though divers of them are profeſſed phyſicians; ſince, as I was induced to what I had done by the dictates of Philanthropy and Chriſtianity, ſo I was warranted by great examples, both in antient times and in ours. Of the former ſort, I take notice of ſeveral of the old philoſophers, ſuch as *Democritus*, *Pythagoras*, to which ſome add *Ariſtotle*; and even divers monarchs and great men of thoſe times, ſuch as *Jubat* king of *Mauritania*; another king, *Nechepſos*, cited by *Galen*, * *Pliny*, &c. And of the ſecond ſort, not only by the laſt age, and the firſt part of our own, but by very late times, and in a neighbouring nation, whoſe cuſtoms we are wont ſufficiently to eſteem and imitate, we may be furniſhed with examples to our preſent purpoſe. For the French king himſelf, who has raiſed the majeſty of a crowned head ſo high, did not think it beneath the grandeur of ſo great a monarch to order the publication of the Engliſh remedy, as the French called the Peruvian bark, which, at a great rate, he purchaſed from *Talbot*, an Engliſh empirick, famous for his many and ſpeedy cures of quartans, and other agues. By the authority of the ſame prince, who has been a great encourager of of divers parts of learning, there has been ſome years ſince ſettled at Paris a ſociety or aſſembly of phyſicians, chirurgions, and others, whoſe main buſineſs is to keep correſpondency in ſeveral parts, and receive informations of the novelties, that occur about diſeaſes, and impart to the public ſuch, as they ſhall think worthy and ſeaſonable; which communications conſiſt not only of new diſcoveries, odd caſes, ſpeculations and obſervations, but of receipts and proceſſes of remedies, printed for the moſt part in French, the common language of the people; divers of which remedies have, upon trial, been found uſeful, as well in *England* as in *France*. There has been alſo lately in that kingdom a book printed more than once, that makes yet for my purpoſe. For there has been publiſhed in the French tongue a large collection of receipts, for almoſt all diſeaſes, placed in alphabetical order; and though theſe receipts are circumſtantially delivered in the mother-tongue of the people, yet they came not forth without the licenſe or authority of the faculty of phyſic; and were (at leaſt the firſt tome) ſo well received and approved, that in divers places the reſpective biſhops authoriſed them by their public approbation, and recommended them upon the account received, or the good effects they had produced, both to the other charitable perſons, and to the curates (or pariſh-prieſts) in their dioceſes.

In complying with the deſires of many, and with the dictates of Philanthropy, I hope, I may procure my medicinal receipts and proceſſes the more favourable reception, if I ſhew, that I might juſtly have a peculiar and perſonal repugnancy to this work. For many may think it ſtrange, as I myſelf have been prone to do, that I ſhould preſume to recommend medicines to others, who, for divers years, have been ſo infirm and ſickly myſelf; and ſome it is like will upbraid me with, *Medice, cura teipſum.* But on this occaſion, I may repreſent, that being the thirteenth or fourteenth child of a mother, that was not above 42 or 43 years old when ſhe died of a conſumption, it is no wonder I have not inherited a robuſt, or healthy conſtitution. Many alſo have ſaid, in my excuſe, as they think, that I brought myſelf to ſo much ſicklineſs by over-much ſtudy. But, I muſt add, that though both the forementioned cauſes concurred, yet I impute my infirm condition more to a third, than to both together; for the grand original of the miſchiefs, that have for many years afflicted me, was a fall from an unruly horſe into a deep place, by which I was ſo bruiſed, that I feel the bad effects of it to this day. For this miſchance happening in *Ireland*, and I being forced to take a long journey, before I was well recovered, the bad weather I met with, and the as bad accommodation in Iriſh inns, and the miſtake of an unſkilful or drunken guide, who made me wander almoſt all night upon ſome wild mountains, put me into a fever and a dropſy,

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* *De ſimpl. medic. facultatibus*, lib. ix. *titulus* Jaſpis Viridis. *Ac nonnulli quoque annulis inſerunt, ſcalpuntque in eo draconem radios habentem: velut rex* Nechepſos *memoriæ prodidit in ſexto et decimo libro.*

(*viz.* an anaſarca;) for a compleat cure of which I paſt into *England*, and came to *London*; but in ſo unlucky a time, that an ill-conditioned fever raged there, and ſeized on me among many others: and though, through God's goodneſs, I at length recovered, yet left me exceeding weak for a great while after; and then, for a farewel, it caſt me into a violent quotidian or double tertian-ague, with a ſenſe of decay in my eyes, which during my long ſickneſs I had exerciſed too much upon critical books ſtuft with Hebrew, and other eaſtern characters. I will not urge, that divers have wondered, that a perſon in ſuch bad circumſtances has by the help of care and medicines (for they forget what ought to be aſcribed to God) ſhould be able to hold out ſo long againſt them. But this, after the foregoing relation, may well be ſaid, that it need be no great wonder, if after ſuch a train of miſchiefs, which was ſucceeded by a ſcorbutick cholick, that ſtruck into my limbs, and deprived me of the uſe of my hands and feet for many months, I have not enjoyed much health, notwithſtanding my being acquainted with ſeveral choice medicines; eſpecially ſince divers of theſe I dare not uſe, becauſe by long ſitting, when I had the palſie, I got the ſtone, voiding ſome large ones (as well as making bloody water) and by that diſeaſe ſo great a tenderneſs in my kidneys, that I can bear no diureticks, though of the milder ſort; and that I am forced to forbear ſeveral remedies for my other diſtempers, that I know to be good ones, and amongſt them divers, that, by God's bleſſing, I have ſucceſsfully tried on others. This ſhort narrative may, I hope, ſuffice to ſhew, that my perſonal maladies and ſickIineſs cannot rightly infer the inefficacy of the medicines I impart or recommended; and if it ſhew that, it will do all, that was aimed at by this repreſentation.

IF ſome receipts or proceſſes (for I hope they will not be many) ſhould happen to be met with in the following collection, that may be alſo found either in ſome printed book or other, it is hoped an indulgent reader will either excuſe or pardon that venial fault; eſpecially if we conſider, firſt, that neither phyſick nor chymiſtry being my profeſſion, I did not think myſelf obliged to peruſe any ſtore of medicinal books, and therefore may well be ſuppoſed to be unacquainted with a great many of them, much more with many of their receipts and proceſſes. And indeed I find by ſome of the latter printed catalogues of books written about the phyſicians art, that there is a multitude of them, which, when I wrote, I had never ſeen, or perhaps ſo much as heard of. Secondly, that it is ſo uſual for authors, eſpecially that writ either ſyſtems or collections, to ſet down ſtore of preſcriptions dictated by their conjectures, not their trials, and yet without giving a diſtinct character of almoſt any of them in particular; that if I had met there with ſome of the ſame, that I am ſpeaking of, I ſhould not have ſelected them from a great number of other undiſtinguiſhed ones: and it is eaſy to obſerve, that there is a great deal of difference betwixt being told by an author, that many things, and among the reſt, but not before them, this or that drug, or receipt, is good for ſuch a diſeaſe, and to have particular notice given of it; and not only to be confirmed, that it is good, but to be told, how good it is, and poſſible alſo, that it may be uſefully employed in other diſtempers beſides thoſe, for which it is preſcribed in the printed book.

THE moſt of theſe receipts are intended chiefly for the uſe of thoſe, that live in the country, in places were phyſicians are ſcarce, if at all, to be had, eſpecially by poor people. And becauſe very frequently a labouring-man, or a handicrafts-man, or ſome tradeſman, has a whole family depending upon him, being maintained by his pains and induſtry, and yet is diſabled to help himſelf and them, not by any internal, but oftentimes accidental maladies; ſuch as bruiſes, ſtrains, cuts, tumours, achs, burns, and the like; I have been careful to furniſh this ſmall collection with a pretty number of good receipts, obtained moſt of them from able ſurgeons and practitioners for thoſe external accidents, that thoſe poor upholders of families, who cannot find or fee a ſurgeon, or a doctor, may be cheaply relieved without either of them.

The AUTHOR's INTRODUCTION to the FIRST VOLUME.

THE following preſcriptions are a part of a collection of receipts and proceſſes, that from time to time have been recommended to me by the experience of others, or approved by my own; receipts, that being parable or cheap, may eaſily be made ſerviceable to poor country people.

For medicines ſo ſimple, and for the moſt part ſo cheap, I have found all of them to be good in their kind; and though I think moſt of them ſafer, than many other medicines, that are in great requeſt, yet I do not pretend, that theſe ſhould play the part of medicines and phyſicians too; but that they may be uſefully employed by one, who knows how to adminiſter them diſcreetly.

I diſtinguiſh them into three claſſes or orders, annexing to the title of each particular medicine one of the three firſt letters of the alphabet; whereof *A* is the mark of a remedy of the higheſt claſſis of theſe, recommended as very conſiderable and efficacious in its kind. *B* denotes a ſecond or inferior ſort, but yet to be valuable for their good operation. *C* belongs to thoſe remedies, that are of the loweſt order, though good enough not to be deſpiſed.

Thoſe receipts, which were my own, are expreſſed in my own terms; ſo alſo thoſe, which I received from others by word of mouth: but them, which were imparted to me in writing, though I myſelf would not have worded them, as they did, that I had them from, yet I oftentimes made a ſcruple to correct or alter their expreſſions, though not ſuitable to the current ſtyle of the formularies of receipts; being more concerned, that the meaning ſhould be cloſe kept to, than the ſtyle rectified.

Mr. BOYLE's RECEIPTS.

DECAD I.

I. *For coughs, eſpecially ſuch as proceed from thin rheums.*

B TAKE of choice *olibanum* finely powdered, from one ſcruple to half a dram, and mix carefully with it an equal weight of ſugar-candy, (white or brown) or, in want of that, of fine ſugar; and let the patient take it at bed-time in the pap of an apple, or ſome other proper additament, for ſeveral nights together: if it be found needful, it may be taken at any other time, when the ſtomach is empty.

II. *To give eaſe in the pains of the Stone, even that of the bladder.*

A TAKE the tranſparent ſparr, that grows upon veins of lead-oar, and having reduced it to fine powder, give from half a dram to a whole dram of it at a time, in a moderate draught of ſome convenient vehicle. *N. B.* Though there be (at leaſt in moſt of our *Engliſh* mines) two teguments, as it were, of the veins of lead, that grow cloſe together; yet that, which the diggers name cawk, which is white and opacous, is not the medicine I mean; but the tranſparent, or at leaſt ſemi-diaphanous, which eaſily breaks into ſmooth fragments, and in the fire cleaves into ſeveral pieces, that are wont to be ſmooth and prettily ſhaped.

III. *For ſharpneſs of urine.*

B TAKE of the dry ſtuff, that divides the lobes of the kernels of walnuts, beat them to powder, and of this give about half a dram at a time, in a draught of white-wine or poſſet-drink made with it, or in any other convenient liquor.

IV. *To appeaſe the violent pains of the tooth-ach.*

B MAKE up a ſcruple of *pilulæ maſtichinæ*, and half a grain of *laudanum*, into two or three pills for the patient to take at bed-time.

V. *For agues.*

A TAKE ſalt of *card. benedict.* and ſalt of wormwood *anà* 15 grains; tartar vitriolate half a ſcruple; mix them, and give them in a few ſpoonfuls of rheniſh-wine, or of ſome other convenient vehicle, either before the fit, or at ſome other time, when the ſtomach is empty,

VI. *For the yellow-jaundice.*

B TAKE an ounce of Caſtile-ſoap (the elder the better) ſlice it thin, put it into a pint of ſmall-beer cold, ſet it on the fire, let it boil gently half away; after boiling ſome time ſcum it once; then ſtrain it through a ſmall ſieve, warm it, and drink it all in a morning faſting; take a ſmall lump of ſugar after it, and faſt two or three hours: the party may walk about his buſineſs, and eat his accuſtomed meals. If at any time he drinks wine, let it be white-wine. *N. B.* If he be far gone in the diſtemper, two or three days after he may take it once or twice more, and no oftener. Refrain all other medicines; it will keep a week or longer.

VII. *For the jaundice.*

B TAKE two or three ounces of *ſemen canabis*, (hemp-ſeed) and boil them till the ſeeds (ſome of them) begin to burſt, and a little longer, in a ſufficient quantity of new milk, to make one good draught; which the patient is to take warm, renewing it, if need be, for ſome days together.

VIII. *For the dyſentery.*

B TAKE pigs-dung, dry it, and burn it to grey (not white) aſhes; of theſe give about half a dram for a doſe, drinking after them about three ſpoonfuls of wine-vinegar.

IX. *For the king's-evil.*

B TAKE cuttle-bone uncalcined, and having ſcraped off the outſide or coloured part, dry the white part; and of this finely powdered give half a dram for a doſe in *aqua malvæ*.

X. *A ſafe and eaſy medicine in the fits of the ſtone.*

B TAKE ſack, or, in want of that, claret-wine; and by ſhaking, or otherwiſe, mix with it, as well as you can, an equal quantity of oil of walnuts; and of this mixture give from 4 or 6, to 8 or 10 ounces at a time, as a clyſter.

DECAD II.

I. *For convulſions, eſpecially in children.*

B TAKE earth-worms; waſh them well in white-wine to cleanſe them, but ſo, as that they may not die in the wine: then upon hollow tiles, or between them, dry the worms with a moderate heat, and no further, than that they may be conveniently reduced to powder; to one ounce of which add a pretty number of grains of ambergreaſe, both to perfume the powder (whoſe ſcent of itſelf is rank) and to make the medicine the more efficacious. The doſe is, from one dram to a dram and a half in any convenient vehicle.

II. *For the piles.*

B TAKE the powder of earth-worms prepared as in the former receipt (but leaving out the ambergreaſe;) and incorporate it exactly with as much hen's-greaſe, as will ſerve to make it up into an ointment. Apply this to the part affected, whoſe pains it uſually much and ſafely mitigates.

III. *To make lime-water uſeful in divers diſtempers.*

C TAKE one pound of good quick-lime, and ſlack it in a gallon of warm water, and let it ſtand, till all, that will ſubſide, be ſettled at the bottom, and (ſeparation being made) the water ſwim clear at the top; (at which time it will often happen, that a kind of thin and brittle ſubſtance, almoſt like ice, will cover the ſurface of the liquor;) as ſoon as the water is thus ſufficiently impregnated, delay not to pour it off warily, and keep it well ſtopped for uſe.

IV. *A lime-water for obſtructions and conſumptions.*

B TAKE a gallon of lime-water made as above, and infuſe in it cold ſaſſafras, liquorice, and anniſeeds, of each four ounces, adding thereto half a pound of choice currants, or the like quantity of ſliced raiſins of the ſun: the doſe of this compound lime-water is four or five ounces to be taken twice a day.

V. *An amulet againſt agues, eſpecially tertian.*

TAKE a handful of groundſel, ſhred and cut it ſmall, put it into a ſquare paper-bag of about four inches every way, pricking that ſide, that is to be next the ſkin, full of large holes; and cover it with ſome ſarcenet or fine linnen, that nothing may fall out. Let the patient wear this upon the pit of his ſtomach, renewing it two hours before every fit.

VI. *For women in labour to bring away the child.*

B TAKE about one dram of choice myrrh, and having reduced it to fine powder, let the patient take it in a draught of rheniſh wine or ſack; or if you would have the liquor leſs active, white-wine, poſſet drink, or ſome other temperate vehicle.

VII. *For ſtrengthening the bowels.*

B TAKE cloves or chives (not bulbs) of garlick, and let the patient from time to time ſwallow one or two, without chewing.

VIII. *An amulet againſt the cramp.*

A TAKE the root of mecboacan, and having reduced it to powder, fill with this powder a little ſquare bag or ſacket of ſarcenet, or ſome ſuch ſlight ſtuff; which bag is to be about three inches ſquare, and to be hung by a ſtring about the patient's neck, ſo that it may reach to the pit of the ſtomach, and immediately touch the ſkin.

IX. *For ſtanching of blood, eſpecially in wounds.*

A TAKE thoſe round muſhrooms, that botaniſts call *crepitus lupi* (in Engliſh puff-balls) when they are full ripe (which is in autumn): and breaking them warily, ſave carefully this powder, that will fly up, and the reſt, that remains in their cavities; and ſtrew the powder all over the part affected, binding it on, or proceeding further, if need be, according to art.

X. *For tumours and pains of the hemorrhoids, not too much inflamed.*

B LET the patient dip his finger in balſam of ſulphur made with oil of turpentine, and, with his finger ſo beſmeared, anoint the tumours, whether external or internal, once or twice a day.

DECAD III.

I. *For the dyſentery, and other ſharp fluxes.*

B TAKE the ſtalks and leaves of the herb called in Latin *coniza medina*, (in Engliſh flea-bane) dry it gently, till it be reducible to powder; of this powder give about one drachm at a time, twice or thrice a day, in any convenient vehicle; or elſe incorporate it in conſerve of red roſes.

II. *To ſweeten the blood, and cure divers diſeaſes cauſed by its acidity.*

B Take coral, the cleareſt and reddeſt you can get; reduce it (by exactly grinding it on a porphyry or marble ſtone) to an impalpable powder. Of this magiſtery made without acids, give the patient once or twice a day, (as need ſhall require) a large doſe, ordinarily about one drachm at a time, or from two ſcruples to five. *N. B.* Let him long continue the uſe of it.

III. *To clear the eyes, even from films.*

A Take *Paracelſus's zebethum occidentale*, (*viz.* human dung) of a good colour and conſiſtence; dry it ſlowly, till it be pulverable: then reduce it into an impalpable powder; which is to be blown once, twice, or thrice a day, as occaſion ſhall require, into the patient's eyes.

IV. *For convulſions in children.*

A Give the patient from two, three, or four, to five, ſix, or ſeven grains, according to the child's age, of the true volatile ſalt of amber, in any proper vehicle. *N. B.* It is not ſo efficacious in full grown perſons.

V. *To bring away the after-birth.*

B Give about thirty drops, or any number between twenty-five and thirty-five, of good eſſential (as chymiſts call it) oil of juniper, in a good draught of any convenient vehicle.

VI. *To ſtrengthen the ſtomach, and help the want of appetite.*

B Make the roots of gentian (ſound and not ſuperannuated) pulverable, with no more waſte of the moiſture than is neceſſary. Reduce theſe to powder, of which let the patient take from twelve or fifteen grains, to double that quantity (or more if need be) twice or thrice a day. *N. B.* It may be taken on an empty ſtomach, or, if that cannot conveniently be done, at meal-times. To correct the bitterneſs, one may add to it powdered ſugar, or make it up with ſome fit conſerve, or mix it with a ſyrup. It is very good, not only for want of appetite, but for obſtructions. And I (*R. B.*) have uſually given it in vertiginous affections of the brain, and to leſſen, if not quite take away, the fits of agues, and even quartans. But, in this laſt caſe, the doſe muſt be conſiderably augmented. One may alſo, if one pleaſes, inſtead of the powder, give the extract drawn with fair water, and for thoſe, that like that form, made up into pills with a ſufficient quantity of powdered turmerick, or the like proper additament; to which I have ſometimes added ſome grains of ſalt of wormwood, with good ſucceſs, in fluxes, that proceeded from crudities and indigeſtion. Where the winter-ſeaſon, or the patient's cold conſtitution invite, or the medicine is to be long kept, I chuſe rather to make the extract with wine moderately ſtrong, than with water.

VII. *For ulcers in the breaſt, and elſewhere.*

A Take millepides (in Engliſh by ſome called wood-lice, by others ſows) and having waſhed them clean with a little white-wine, and dried them with a linen cloth, beat them very well in a glaſs or marble mortar, (for they ought not to be touched with any thing of metal) and give the firſt time as much juice as you can by ſtrong expreſſion obtain from five or ſix of them. This juice may be given in ſmall-ale or white-wine, in which the next time you may give as much, as can be ſqueezed out of eight or nine millepides; and ſo you may continue increaſing the number, that you employ of them, by two or three at a time, till it amount to twenty-five or thirty; and if need be, to forty or more, for one taking. And note, that if, upon pounding of theſe inſects, you find the maſs they afford too dry, as it now and then happens; you may dilute it with a little white-wine or ale, to be well agitated with it, that being penetrated and ſo ſoftned with the liquor, the maſs may the better part with its juice.

VIII. *For taking off the fits of agues.*

Take good common brimſtone (not *flores ſulphuris*) and having reduced them, by paſſing them through a very fine ſieve, to the ſubtileſt powder you can, give of this powder one drachm and half, or two drachms, either made up into a bolus with a little good honey, or elſe in any appropriated vehicle; let it be given at the uſual times, and reiterated once or twice, if need be, eſpecially if the fits ſhould return.

IX. *For fluxes, eſpecially accompanied with gripings.*

Take of *crude lapis calaminaris* finely powdered two ſcruples, of white chalk one ſcruple; mix them exactly, and give them in a ſpoonful or two of new milk twice, or, if the caſe be urgent, thrice a day.

X. *For the pains of the piles.*

B Take of myrrh, olibanum, and common frankincenſe, of each a like quantity; having powdered them, mix them very well, and let the patient receive the fume of this mixture, caſt upon a chaffing-diſh with embers, in a cloſe-ſtool, for about a quarter of an hour (leſs or more, as he needs it, and is able to bear it.)

DECAD IV.

I. *For an outward contuſion.*

Apply to the part affected ſkim'd or purified honey, ſpread upon cap-paper, to be kept on with ſome convenient plaiſter, or the like bandage, and ſhifted once or twice a day.

II. *Another of the ſame.*

A Beat aloes ſuccotrina (or elſe hepatica) to fine powder; then pour on it as much roſe-water, as you gueſs may diſſolve a great part of it: this done, ſtir them well for a while, and, when the mixture is ſettled, pour off the liquor, and in it dip linen-rags, which being applied to the part affected will ſoon ſtick to it, and ſeldom need be removed till the patient be relieved; and then to get them off, the rags muſt be well wetted with warm water, which will ſoften and looſen the adhering aloes.

III. *For a ſlighter excoriation.*

B Melt mutton-ſuet taken from about the kidneys, and freed from its ſuperfluous fibres or ſtrings; and to about two ounces of this add, little by little, about ſixteen or eighteen drops (ſometimes eight or ten may ſerve) of oil (not æthereal ſpirit) of turpentine; ſpread this mixture on a linen-cloth, and, by binding or otherwiſe, keep it upon the part affected.

IV. *For an excoriation, when the true cutis is affected.*

B Take prunella (in Engliſh ſelf-head) and having pounded it very well in a marble or glaſs mortar (not one of metal) apply it to the part affected, renewing it but ſeldom, and not without need.

V. *To take off the pain and inflammation of ulcers in the legs and elſewhere.*

B In a quart of water boil about ſo much white-bread, as in ordinary years may be found in a half-penny loaf; then add to it two ounces of good ſheep-ſuet cut very ſmall; and when that is boiled a little, add to it one ounce of finely powdered roſin, and a little well ſearſed brimſtone: of theſe make a cataplaſm, which is to be kept conſtantly on the part affected, and ſhifted once or twice a day, as need ſhall require.

VI. *For a cough, eſpecially accompanied with tickling rheum.*

B Take equal parts of finely powdered olibanum and venice-treacle, incorporate them exactly, and of this maſs form pills of what bigneſs you pleaſe: of theſe let the patient take about half a drachm at bed-time, or, if need be, one ſcruple (or more) twice a day.

VII. *To prevent the tooth-ach, and keep the teeth ſound.*

B Let the patient frequently rub his teeth moderately with the aſhes, that remain in tobacco-pipes, after the reſt of the body hath been conſumed in ſmoak; ſome time after, waſhing (if need be) his mouth with fair water not too cold.

VIII. *For a rupture, eſpecially in a child or young perſon.*

A Take of that geranium or crane's-bill, that is commonly called columbinum, reduce the root and leaves to fine powder, and of this let the patient take about half a ſpoonful at night and morning for three or four weeks together, waſhing it down each time with ſome ſpoonfuls of red-wine.

IX. *For the heart-burning, as they call it.*

B Take from fifteen or twenty, to thirty or forty grains of crabs-eyes (known commonly in the ſhops by the name of lapides cancrorum) reduced to very fine powder, and either take it alone, or in any convenient conſerve or ſyrup. It is for the moſt part beſt to take this medicine, when the ſtomach is empty.

X. *For a ſtrain.*

B Take the ſtrongeſt vinegar you can get, and boil in it a convenient quantity of wheat-bran, till you have brought it to the conſiſtence of a poultis. Apply this as early as may be to the part affected, and renew it, when it begins to grow dry.

DECAD V.

I. *For a recent ſtrain.*

B Take wormwood, and pound it very well in a mortar of ſtone or glaſs; then put into it as much of the whites of eggs beaten to water, as may ſerve to make it up into ſuch a conſiſtence, as may be applied like a poultis to the part affected.

II. *A ſtrengthening plaiſter after a ſtrain, or when there is any weakneſs in the joint.*

B MELT down together, and incorporate very well, two parts of *diapalma*, and one part of *emplaſtrum ad herniam*; ſpread this mixture (but not very thick) upon leather, and lay it to the joint to be ſtrengthned.

III. *For Looſneſſes.*

C BOIL a convenient quantity of cork in ſpring-water, till the liquor taſte ſtrong thereof; of this decoction let the patient drink a moderate draught from time to time, till he finds himſelf relieved by it.

IV. *For obſtructions, and divers diſeaſes proceeding thence.*

B LET the patient drink every morning a moderate draught of his own urine newly made, and (if it can conveniently be) whilſt it is yet warm, forbearing food for an hour or two after it.

V. *For difficulty of hearing from a cold cauſe.*

B OUT of a bulbe, or root of garlick, chuſe a chive of a convenient bigneſs; then having paſſed a fine piece of thread or ſilk through one end of it, that thereby it may be pulled out at pleaſure, cruſh it a little between your fingers, and having anointed it all over with oil of bitter, (or, for want of that, ſweet) almonds, put it into the cavity of the patient's ear at bed-time, and draw it out the next morning, ſtopping the ear afterwards with black wool; but if need require, this operation is to be reiterated with freſh garlick for ſome days ſucceſſively.

VI. *For ruptures in the belly, eſpecially in children.*

A HAVING well cleanſed the roots of ſigillum Salamonis, ſcrape one ounce of them into a quart of broth, and let the patient take a meſs, or a porringer full of it for his breakfaſt; or elſe give half a drachm, or two ſcruples, of the powder of it at a time in any convenient vehicle.

VII. *To give check to fits of the gout, and in ſome meaſure to prevent them.*

B TAKE three ounces of ſarſaparilla ſliced and cut thin; to theſe add an equal weight of raiſins of the ſun, rubbed very clean, but not broken; put both theſe ingredients into three quarts of ſpring-water, and let the veſſel ſtand in a moderate heat, that the liquor may ſimper for many hours, yet without burſting moſt part of the raiſins; keep this decoction well ſtopt, and let the patient uſe it for his only drink, till he need it no longer.

VIII. *A water for ulcers and ſores.*

B TAKE a ſolution of Venetian ſublimate, and having made with very good quick-lime as ſtrong a lime-water as you can, (ſo that, if it be poſſible, it may bear an egg) drop this upon the diſſolved ſublimate, till it will precipitate no more reddiſh ſtuff at all; (which will not ſo ſoon be done, as one, that hath not tried, will imagine :) as ſoon as you perceive, that the liquors act no longer viſibly upon one another, pour the mixture into a filter of cap-paper, which, retaining the orange-coloured precipitate, will tranſmit an indifferently clear liquor, which is to be in a glaſs-vial kept ſtopt for its proper uſe; namely, that the part affected may be therewith waſhed from time to time, and, if need be, kept covered with double linen-cloths wetted in the ſame liquor.

IX. *A plaiſter to diſcuſs tumors, and ripen them, if it cannot diſcuſs them.*

B TAKE of yellow wax, frankincenſe, and roſin, of each four ounces, or a ſufficient quantity; melt them together gently, and being ſtrained, make up the maſs into a roll for uſe.

X. *For the black Jaundice itſelf.*

B TAKE a ſpoonful of honey, boil it gently, and ſcum it, till it come to a good conſiſtence: then add of wheat-flour and ſaffron (reduced to a powder) as much of each, as you may take upon the point of a knife; and having mixed all well, put it over the coals again, until it loſe its ſmell; afterwards you may put it into a little ſtone or earthen-pot, and keep it for uſe; which is, that the patient take the quantity of a pea, and anoint the navel, and fill the cavity thereof with it; repeating the application for ſome days together, when the ſtomach is empty, and abſtaining from meat and drink about two hours after the medicine is uſed.

DECAD VI.

I. *A parable medicine for the ſtone.*

B TAKE of the ſeed of flixwood, and give of it about as much, as will lie upon a ſhilling, either whole or groſly bruiſed, in any convenient vehicle.

II. *For fits of the mother.*

B DISSOLVE ſtore of ſea-ſalt in the beſt wine-vinegar, and in this dip a ſoft linen cloth, which being folded ſo, as to make three or four doubles, is to be applied ſomewhat warm to the ſole of the patient's feet, and kept on, till the fit be over.

III. *A choice plaiſter to ſtrengthen the joints after the gout, and haſten the going off of the pain.*

A Take of Paracelſus and diapalmaana, melt them and incorporate them exactly together, and ſpread the mixture very thin upon fine leather, to be uſed as a plaiſter to the part affected.

IV. *A very good drink in continual fevers.*

A Make a decoction of the leaves of rue in fair water, till the liquor taſte pretty ſtrong of the plant; this being ſtrained, is to be made ſomewhat palatable with liquorice, or a little ſugar, or aromatic body; to half a pint of this add about ten drops of ſpirit (not oil) of vitriol: let the patient uſe this for his ordinary drink.

V. *A good drink, to be frequently uſed in fevers, eſpecially continual ones.*

A Give in half a pint of ſome ſmall convenient drink, half an ounce of hartſhorn, burnt to great whiteneſs, which is to be a little boiled in the liquor; and this, thus altered, is to be given from time to time.

VI. *An eaſy medicine for a freſh ſtrain.*

B Make up the clay, with which the bungs of barrels are wont to be ſtopt, with as much vinegar, as will bring it to the conſiſtence of an indifferently ſtiff cataplaſm: then warm it a little, and apply it to the part affected.

VII. *A remedy much uſed for chilblains.*

C Take a turnip, roaſt it well under the embers, and beat it to a poultice; then apply it very hot to the part affected, and keep it on (if need be) for three or four days; in that time ſhifting it twice or thrice, if occaſion require.

VIII. *A ſimple antimonial remedy, that has often done much good even in the leproſy, and all continual fevers.*

A Take crude antimony, well choſen and powdered; of this give about one, two, or three ſcruples morning and evening, according to the age of the patient, in a little ſyrup of clove-gilly-flowers, or any ſuch vehicle, or elſe mixed with fine ſugar, enough to make it ſomewhat palatable. This may be continued for four or five months, if need require; and if the firſt doſe prove beneficial to the patient, in caſes not urgent, a ſcruple or half a drachm may ſerve the turn, nor need the exhibition be continued for ſo long a time.

IX. *For the cholic and divers other diſtempers.*

B Take four or five balls of freſh ſtone-horſe-dung, and let them ſteep for about a quarter of an hour (or leſs) in a pint of white-wine, in a veſſel well ſtopt, that the liquor may be richly impregnated with the more volatile and ſubtile parts of the dung; ſtrain this, and give of it from a quarter to half a pint, or ſome ounces more at a time, the patient having a care not to take cold after it.

X. *An often experienced antimonial infuſion.*

B Take one ounce of powdered antimony tied up in a little bag of clean linnen, and hang it in a gallon of beer or ale, that is brought from the brewhouſe, and is yet ſcarce fit to be drawn out, much leſs to be drank. Of this liquor, when it is ripe, let the patient make uſe for his ordinary drink; only having a care, that if by age or accident it be perceived to grow ſowre, that veſſel then be left off, for fear leſt the acidity of the liquor corroding the antimony might make it vomitive.

DECAD VII.

I. *An eaſy medicine to cleanſe the womb, eſpecially after child-bearing.*

B Take a large white onion, of about four ounces in weight, (if you can get ſo big a one, and boil it in about a pint of water, with any thing fit to make a very thin broth, till a third part or more of the liquor be conſumed: of this broth, which may be made a little palatable with nutmeg, &c. the patient is to take ſix or eight ounces twice or thrice a day.

II. *An experienced waſh, that quickly cures the itch.*

A Take ſtrong quick-lime, one pound, and put to it a gallon of ſpring-water; let them lie together for ſome hours, and then warily pour off the clearer; filter the reſt, and take two ounces of quickſilver, tied up in a linen bag, and hang it in the liquor, and boil it for half an hour or more; then pour off the clear liquor once more, and waſh the hands only with it twice, or at moſt thrice a day.

III. *A remedy often uſed with ſucceſs in fluxes, and even dyſenteries.*

B Take freſh roots of biſtort, cut them into thin ſlices, and moiſten them well with with fair water and wine, to make them more ſoft and ſucculent; then preſs out the juice as ſtrongly as you can; and of this give about three or four ſpoonfuls mingled with half a dozen ſpoonfuls, or ſomewhat more, of red wine, or ſome other convenient liquor.

IV. *A good medicine for a ſore throat.*

B Take the white of a new-laid egg, and, by beating it, reduce it into water; and with this water mix diligently ſo much conſerve of red roſes, as will reduce it to a ſoft maſs; whereof the patient is to let a little bit at a time melt leiſurely in his mouth.

V. *A choice medicine for a ſore throat.*

A Take a piece of greaſy linen cloth, of ſuch a bigneſs, as, that being doubled, may make a bag in form of a ſtay, to reach from one ſide of the throat to the other, and contain as much matter, as may make it of the thickneſs of an inch or more: this bag being filled with common ſalt, is to be heated throughly, and applied to the part affected as warm as the patient can conveniently endure; and within two hours after, or when it begins to grow too cold, another like it, and well heated, is to be ſubſtituted in its room; and whilſt this is cooling, the other may be heated, and made ready for uſe: ſo that the part affected may be always kept in a conſiderable degree of warmth, for about 48 hours, if the remedy be ſo long needed.

VI. *An often experienced medicine for the cholic, eſpecially produced by ſharp humours.*

A Take a quart of claret, and put into the veſſel about two ounces of nettle-ſeeds, ſtop the bottle, and keep it in boiling water, till the water has made three or four warms, to aſſiſt the wine's impregnation with the finer part of the ſeeds: of this liquor let the patient take a ſmall draught once or twice a day.

VII. *To appeaſe the pain of the hæmorrhoids, whether internal or external.*

B Take two parts of flower of ſulphur, and one part of ſugar very finely powdered, mix them exactly together, and make them up with a ſufficient quantity of mucilage or gum trajacanth into lozenges of about a drachm a-piece: of which you may give one at a time thrice a day, or, if need be, four or five times.

VIII. *To make an excellent drink for the ſcurvy.*

A Take two handfuls of water-trefoil, and let it work in about eight gallons of wort inſtead of hops, or of ſmall-ale or wort, made for it; and let the patient uſe it for all, or for a great part of his ordinary drink.

IX. *To make an eaſy diuretic.*

C Peel off the inner ſkin of an egg-ſhell, then beat the ſhell to a very fine powder: give about a ſcruple of it at a time in any convenient vehicle.

X. *A powerful application to prevent and check the apoplexy.*

A Make an iſſue at the meeting of the ſutures, and keep it open for a good while: but if the caſe will not admit a delay, clap on a good cupping-glaſs, without ſcarrification, or with it, as need ſhall require, upon the ſame concourſe of the ſutures.

DECAD VIII.

I. *A choice medicine for a ſore throat.*

A TAKE houſleek, and having lightly beaten it in a glaſs or ſtone mortar, preſs out the juice hard between two plates; to this juice put almoſt an equal quantity of virgin-honey, mix them well, and add to the mixture a little burnt allum, as much as is requiſite to give it a diſcernable alluminous taſte: let the patient take this from time to time, with a liquoriſh ſtick, or ſome ſuch thing.

II. *An approved medicine for a cancer not broken.*

B Take dulcified colcothar, and, with cream of whites of eggs beaten to a water, bring it to the conſiſtence of a cataplaſm; which ought to be made large, and ſpread about the thickneſs of half a crown, and applied warm to the part affected, ſhifting it at leaſt once a day.

III. *To make a very good ſyrup for thin rheums.*

A Take ſyrup of jujubes, ſyrup of dried roſes, and ſyrup of corn poppy-flowers, of each a like quantity, mix and uſe them as the neceſſity of the ſick requires.

IV. *For the dyſentery and pleuriſy.*

B Grate to fine powder the dried pizzle of a ſtag, and give of it as much as will lie upon a ſhilling or thereabouts, once or twice a day, in any convenient vehicle.

V. *To ſtrengthen the gums, and make the teeth grow fine.*

B Take catechu, terra Japonica, or Japonian earth, and diſſolve as much as you can of it in a pint of claret, or red wine; then decant the liquor warily from the ſubſiding fœces, and let the patient now and then waſh his mouth with it, eſpecially at bed-time.

VI. *For a hoarſeneſs upon a cold.*

B Take three ounces of hyſſop-water, ſweeten it with ſugar-candy; then beat well into it the yolk of an egg, and drink it at a draught.

VII. *A choice medicine for the jaundice in children.*

A Take half an ounce of choice rhubarb made into powder; incorporate with it exactly, by long beating, two handfuls of well choſen and cleanſed currants. Of this electuary let the patient take every morning about the quantity of a nutmeg, for ſeveral days together.

VIII. *A rare medicine to take away gouty, or other arthritick pains.*

A Take highly rectified ſpirit of man's urine, and anoint the part with it, the cold being juſt taken off, once or twice the firſt day, and no longer, unleſs the pain continue.

IX. *For a prolapſus uteri.*

B Apply to the patient's navel a pretty large cupping-glaſs; but let it not ſtay on too long, not above a quarter of an hour, for fear of injuring the part it covers, eſpecially the navel-ſtring.

X. *To allay heat in the eyes proceeding from ſharp humours.*

B Beat the white of an egg into a water, in which diſſolve a pretty quantity of refined loaf-ſugar, and then drop ſome of it into the patient's eye.

DECAD IX.

I. *An experienced medicine for ſtrengthning a weak ſight.*

B Take of eye-bright, ſweet fennel-ſeeds, and fine ſugar, all reduced to powder, of each an ounce, nutmeg alſo pulveriſed, one drachm (at moſt;) mix theſe very well together, and take of the compoſition from one drachm, to two or more, from time to time.

II. *An often tried medicine for tertian agues.*

B Take crude allum and nutmeg finely ſcraped, of each about half a drachm, mix the powders well together, and with about ſix grains of ſaffron: give this in two or three ſpoonfuls of white-wine vinegar, at the uſual time.

III. *For ſtuffing of the lungs, and the chin-cough.*

B Make ſyrup of penny-royal, or of ground-ivy, moderately tart with oil of vitriol; and of this let the patient take very leiſurely about a quarter of a ſpoonful from time to time.

IV. *For the falling-ſickneſs in children.*

B Take half a dram of choice amber, finely powdered, and give it for ſix or ſeven weeks together, once a day, when the ſtomach is empty, in about four ounces of good white-wine.

V. *An approved medicine to drive the ſtone, and cure ſuppreſſion of urine proceeding from it.*

A Take the roots of wild garlick (by ſome country people called crow garlick) wipe them very clean, ſtamp them very well in a mortar of ſtone or glaſs, and ſtrain out the juice; with which make a moderate draught of good white wine conſiderably ſtrong, and let the patient take it once or twice a day.

VI. *An experienced medicine for ſore throats.*

A Take of ſcabius water ſix ounces, of wine-vinegar a ſmall ſpoonful, of muſtard-ſeed beaten, and of honey, of each a ſpoonful; and ſtir and ſhake them very well together; and then filter the mixture, and keep it for uſe.

VII. *An often experienced external remedy in apoplectick fits.*

A Fix a cupping-glaſs (without ſcarification) to the nape of the neck, and another to each of the ſhoulders, and let them ſtick on a competent time.

VIII. *An eaſy, but approved medicine for the cholick.*

B Take about half a dram of maſtick, and mix it with the yolk of a new-laid egg, and give it to the patient once or twice a day.

IX. *To appeaſe the heat of fevers by an external remedy.*

C Apply to the ſoles of the feet a mixture or thin cataplaſm made of the leaves of tobacco, fit to be cut to fill a pipe with, beaten up with as much of the freſheſt currants you can get, as will bring the tobacco to the conſiſtence of a poultis.

X. *The medicine, that is in ſuch requeſt in* Itay, *againſt the worms in children.*

B Infuse one dram of clean quick-ſilver all night, in about two ounces of the water of goats rue, diſtilled the common way in a cold ſtill; and afterwards ſtrain and filter it, to ſever it from all dregs that may happen in the making it. This quantity is given for one doſe.

DECAD X.

I. *A choice medicine for a whitloe.*

A TAKE ſnail-ſhells, and beat the pulpy part of them very well, with a convenient quantity of fine chopped parſly, which is to be applied warm to the affected part, and ſhifted two or three times a day.

II. *A ſimple but uſeful lime water good for the king's-evil, and divers other cauſes.*

B Take half a pound of good quick-lime, and put it into one gallon of ſpring-water, and infuſe it for twenty-four hours; then decant the liquor, and let the patient drink a good draught of it two or three times a day, or he may uſe it for his ordinary drink; this infuſion may be coloured with ſaffron or red-ſanders; and, if need be, to make it ſtronger, add more lime, and warm the water and keep it well ſtopped.

III. *An excellent medicine for a freſh ſtrain.*

A Take four ounces of bean-flower, two ounces of wine-vinegar; of theſe make a cataplaſm to be applied a little warm to the part affected; but if this ſhould prove ſomething too ſharp (as in ſome caſes it may) then take two drams of litharge, and boil it a little in the vinegar before you put in the bean-flower.

IV. *For the piles.*

A Take balſam of ſulphur made with oil of turpentine, ointment of tobacco, equal parts, incorporate them well, and anoint the grieved place therewith.

V. *For a burn.*

B Mingle lime-water with linſeed-oil, by beating them together with a ſpoon, and with a feather dreſs the burn ſeveral times a day.

VI. *For a freſh ſtrain.*

A Boil bran in wine-vinegar to the conſiſtency of a poultis, apply it warm, and renew the poultis once in twelve hours for two or three times.

VII. *An experienced medicine for the cholic.*

A Take good nitre, one ounce, and rub it well in a clean mortar of glaſs or ſtone; then grind it with half a ſcruple or more of fine ſaffron; and of this mixture give about half a dram for a doſe, in three or four ounces of cold ſpring-water.

VIII. *To make an iſſue raw, that begins to heal up.*

B Take of *lapis infernalis* one ounce, of crown-ſoap an ounce and an half, chalk finely powdered ſix drams, mix them all together carefully, and keep them cloſe ſtopped, except when you mean to uſe them.

IX. *For a ſore throat.*

A Make a plaiſter of *Paracelſus*, three or four fingers broad, and length enough to reach almoſt from one ear to the other, and apply it to the part affected, ſo that it may touch the throat, as much as may be.

X. *For heat about the orifice of the ſtomach.*

B Make a ſyrup with the juice of houſeleek and ſugar, and give about one ſpoonful of it from time to time.

XI. *A ſtomachical tincture.*

A Take agrimony, two drams, ſmall centory-tops, one dram, coriander-ſeeds bruiſed, one ſcruple, ſaſſafras-ſhavings and bark, one dram, gentian-root, half a dram, zedoary-root, ten grains; pour upon theſe three quarters of a pint of boiling ſpring-water, cover it, and let it ſteep twelve hours, then ſtrain it, and put it in a bottle; then drop a drop of oil of cinnamon upon a lump of ſugar, and put it into the liquor. The doſe is three ſpoonfuls twice a day, an hour or two before meals.

The END *of the* First Volume.

MEDICINAL EXPERIMENTS:
OR, A
COLLECTION
OF
Choice and Safe REMEDIES
Very Uſeful in all FAMILIES.
The SECOND VOLUME.

I. *A powerful remedy in apoplectic fits.*

TAKE the herb maſtic, and diſtill, by an alembic, with a copper body, an eſſential oil, of which, with ſuch a pipe or quill, that one end may be opened and ſtopped at pleaſure, (the other ſtill remaining open) blow up ſome drops firſt into one of the patient's noſtrils, and a while after into the other too.

II. *A good plaiſter for achs, eſpecially ſcorbutical.*

Spread thinly upon ſlink, or very fine kids leather, the *emplaſtrum de mucilaginibus*, and let it lie upon the aching part as long as there is need.

III. *For an old ach or ſtrain.*

Take of *Lucatella*'s balſam one ounce, of oil of turpentine one dram, incorporate them very well with a gentle heat, and anoint the part affected therewith, wearing on it a piece of unwaſhed flannel beſmeared with the ſame ointment.

IV. *For ſcorbutick achs, eſpecially about the the ſhare-bone.*

Take two parts of palm-oil, and one of oil of camomile (to which, if you pleaſe, you may add a little ointment of elder) mix theſe exactly, and anoint the part affected.

V. *A powerful remedy for ſcorbutic achs.*

Take to one ounce of oil of turpentine, one dram or two of the volatile ſalt of hartſhorn, or as much as being well ground with it in a mortar of glaſs or marble, will bring it to the conſiſtence of a kind of ointment, with which, the cold being taken off, the part affected is to be lightly anointed.

VI. *A very eaſy medicine for light ſcorbutick achs or pains.*

Anoint the pained part from time to time with faſting-ſpittle; and if you will have the medicine a little ſtronger, the patient may put roch-allum to the bigneſs of a ſmall pea into his mouth before he employs his ſpittle.

VII. *For achs and pricking pains in the ſides or elſewhere.*

With a ſufficient quantity of clean ſulphur finely powdered mix diligently as much Venice treacle as will bring it to the conſiſtence for pills. Of this mixture you may give the quantity of a piſtol-bullet twice, or, at moſt, thrice a day, drinking any convenient liquor after it.

VIII. *An experienced remedy for an anaſarca, or general diſeaſe of the whole body.*

Fry freſhly gathered rue with oil of walnuts, till it become fit to be applied hot as a cataplaſm or poultis to the navel; and keep it on that part ſome hours, renewing it once or twice a day, if need require.

IX. *An external medicine often ſucceſsfully tried for agues.*

Take five, ſeven or nine (for it is pretended it muſt be an odd number) of the roots of rib-wort, and having made them clean, put them into a little bag of ſarſenet or fine linnen, and let the patient wear it upon the nape of his neck, renewing it within two, three, or four days, if need require.

X. *A tried remedy for agues.*

Take of the bark of ſaſſafras-root, and of Virginian ſnake-weed, both in powder, of each ten grains; and with half a dram, or two ſcruples of mithridate or Venice-treacle, or as much as will give it a due conſiſtence, make a bolus to be taken the uſual hours.

XI. *A choice medicine for aguiſh diſtempers.*

TAKE of ſalt wormwood fifteen grains, crabs-eyes, or powder of crabs-claws ſimple, eight or ten grains; mix theſe well, and give them in two or three ſpoonfuls of ſome cordial water.

XII. *An excellent wriſt-plaiſter for agues.*

TAKE wax, and ſpread it to about the thickneſs of a crown-piece of ſilver, and of a convenient breadth and length to make an entire wriſt plaiſter; upon this ſpread and diſplay as well as you can the leaves of the tops of rue not yet fully opened by time, ſo that they may cover the whole plaiſter as well as you can make them do it. Then apply this emplaiſter, and let it lie on ſeveral days conſecutively.

XIII. *An often tried medicine for agues.*

TAKE ribwort, gather the leaves as near the root as you can in a dry morning, wipe them clean, but do not waſh them; then dry them carefully, till you may reduce them to powder. Of this powder give from one dram to two at moſt, mixed with one dram of conſerve of roſes, or the crumbs of white-bread, or the yolk of an egg or two. [*N. B.*] You may, before you dry the leaves, diſtill a water out of ſome of them, and make an extract out of others with ſpirit of wine, or, which is better, with ſpirit of dew. They are both good for the ſame diſeaſe that the powder is. The doſe of the water is one ounce, or an ounce and an half, at the uſual times; and that of the extract about one dram in ſome ounces of white wine.

XIV. *An excellent medicine for agues, eſpecially tertians.*

GIVE as much of well-conditioned Virginian ſnake-root reduced to fine powder, as will lie upon a ſhilling, in a cup of ſherry, juſt before the beginning of the cold fit, repeating it once or twice, if it need to be uſed oftner.

XV. *For a tertian ague.*

TAKE of the root of angelica grated, or otherwiſe made into powder, and give of it from half a dram to a dram, in any convenient vehicle at the uſual times (*viz.* about two hours before the cold fit.)

XVI. *A medicine, with which a quartan was cured, that could not be cured with Jeſuits-bark.*

TAKE one dram of the black tips of crabs-claws, and having reduced them to exceeding fine powder, let the patient take it in any convenient vehicle or conſerve, twice or thrice, as he would take the cortex, without intermitting any day.

XVII. *An eaſy remedy, which, long continued, does much deſtroy acidities or heart-burnings in the ſtomach.*

TAKE half a dram at leaſt of finely powdered red coral, and give it from time to time in any convenient vehicle, till the patient be relieved.

XVIII. *A very often tried remedy for the aſthma.*

TAKE ſoap-boilers lees (made with pot-aſhes and quick-lime) one part, ſpirit of wine rectified two parts; ſet them in digeſtion (to unite them well) and then add ſome drops (at diſcretion) chymical oil of carraways, and if you pleaſe, of anniſeeds too. The doſe in younger perſons is about ten drops, in elder ones, from half a dram to one dram, in ſome convenient vehicle.

XIX. *An excellent medicine for a dry or convulſive aſthma.*

TAKE choice ſaffron, reduce it (by rubbing it in a ſtone or glaſs mortar) to a kind of powder, and with, any convenient mixture, give eight or ten grains of it in the form of pills at bed-time.

XX. *An experienced remedy for difficulty of breathing.*

TAKE of choice *Caſtoreum* dried enough to be powdered, two or three, or at moſt four grains, mix this with ten or eleven grains of *Gaſcoign*'s powder reduced to very fine powder; mix up theſe with ſome little ſyrup or conſerve; and when the patient has taken it, let him waſh it down with the mixture, conſiſting of five drams of penny-royal-water, and half a dram, or at moſt two drams of briony-water compound.

XXI. *An approved medicine for inveterate ſcorbutick cholics, and pains of the bowels.*

TAKE Engliſh barley, and having well waſhed it, boil it in a ſufficient quantity of freſh ſpring-water, till it be juſt ready to burſt: then pour off the clear upon the yellow part of the rinds of lemons, freſhly cut off from the white part, and put them into a bottle, which being carefully ſtopped, the liquor is to be kept ſo for uſe, which is, that the patient make it his conſtant drink.

XXII. *To reduce flaggy breaſts to a good ſhape and conſiſtence.*

TAKE green hemlock, well bruiſed and reduced to a kind of cataplaſm or poultis, which is to be applied (the cold being firſt taken off) to the parts it is to work upon, and to be kept on, till it hath performed what was intended, ſhifting it once a day.

XXIII. *An eaſy, but uſeful remedy for a freſh bruiſe or contuſion.*

TAKE freſh butter and parſley, of each a ſufficient quantity, and having chopped the herb, mix it very well with the butter to the conſiſtence of a cataplaſm, which is to be applied warm, to the newly bruiſed part.

XXIV. *For coagulated blood, or a bruiſe.*

TAKE black ſoft ſoap, and, with a ſufficient quantity of ſoft crumbs of white-bread very well mixed with it, make a paſte, which is to be laid on the part with a linnen rag, and kept bound upon it for ſome hours, that it may have time to reſolve the congealed blood, and bring the contuſed part from a livid to a red colour, which will much haſten and facilitate the reſtoring it to its former ſtate.

XXV. *To ſtanch blood falling from the noſe, by a ſimple held in one's hand.*

LET the patient hold knot-graſs and Solomon's-ſeal in his hand, till it grow warm there, or longer, if need be.

XXVI. *An excellent remedy to ſtanch blood in any part of the body.*

TAKE plantane-water two ounces, barley-cinnamon-water, ſix drams, ſpirit of vinegar one ounce, dragons-blood half a dram, ſyrup of myrtles five drams; mix and make a julep, of which let the patient take three ſpoonfuls every hour.

XXVII. *The ſtyptick water for ſtopping of blood in any part of the body.*

TAKE one pound of excellent quick-lime, and put it into a clear earthen-pot, pour upon it five or ſix pounds of fountain-water, cover the pot cloſe, and let it lie to infuſe about an hour without touching it, then after ſtir it with a ſtick for a little time; then let it lie as before for twenty-four hours, ſometimes ſtirring it; in the end you ſhall let it ſettle to a ſediment; the water being very clear above, pour it off by inclination without ſtirring: take of this water one pound, which being put into a vial, you ſhall add to it a dram and half of ſublimate finely powdered; then ſhake very well all together, ſo that the powder may diſſolve, and be of an orange colour, as more reddiſh than yellow, and in the end clear and limpid, becauſe the red powder will precipitate to the bottom. Your water being clarified, you muſt ſeparate the water from the grounds into another veſſel, without troubling the ſediments; and to the water you ſhall add one dram of oil of vitriol, and an ounce of *ſaccarum Saturni*. Shake all together, that they may mix the better; afterwards let all ſettle, and pour off the clear water, and keep it for your uſe.

XXVIII. *A choice medicine to reſolve extravaſated blood.*

GRATE or raſp the root of burdock, and ſpreading the powder upon a linnen cloth, bind it round the part affected, renewing it twice a day.

XXIX. *To make an excellent ſtyptick for ſtopping of blood.*

TAKE Hungarian vitriol, allom, of each half a pound, phlegm of vitriol ten pounds: boil to a diſſolution of the vitriol and allom; being cold, filter it through brown paper, and, if any cryſtals ſhoot, ſeparate the liquor from them, adding to each pound one ounce of oil of vitriol. Dip cloths into this liquor, and apply them to the part affected.

XXX. *An often tried ſtyptick to ſtanch blood, eſpecially in wounds.*

TAKE colcothar, as it comes out of the retort, and having powdered it, roll tents of lint in it, and apply them to the orifices of the greater veſſels, and employ other uſual means to impreſs the veſſel upon the tent, and to fill the cavity of the wound, partly with colcothar too.

XXXI. *A very often experienced remedy for burns.*

TAKE two parts of oil of walnuts, and one of honey, mix them well together over a gentle fire, and, when they are thoroughly incorporated, dip a feather in the mixture, and anoint therewith the part affected ſo, as the ointment may touch it immediately, and then ſtrew on it ſome powder of ceterach, or ſpleen-wort, and keep the part quiet, and defend it from the air.

XXXII. *An eaſy medicine, and common enough, but uſeful againſt burns.*

TAKE onions, and beat them into a ſoft maſs, and apply them as ſpeedily as you can to the part affected, and keep them on it, till they begin to grow dryiſh, and then, if need be, ſhift them, and apply freſh ones.

XXXIII. *For a recent burn.*

TAKE onions a ſufficient quantity, and beat them very well with common ſalt finely powdered into a maſh, that may be applied as a cataplaſm (the cold being firſt taken off) to the part affected; and renewing it, if need be, till the impreſſion of the fire be taken out.

XXXIV. *An excellent ointment for burns and ſcaldings.*

Take of the inner rhind of elder-tree, and of freſh ſheep's-dung, without any adhering ſtraws or foulneſs, of each one handful, and with freſh butter or oil, make thereof an ointment, to be applied as is uſual in ſuch diſtempers.

XXXV. *An eaſy and approved remedy for burns, eſpecially recent ones.*

Take a ſufficient quantity of adder's-tongue, and boil it ſoftly in linſeed oil, till the liquor be ſtrongly impregnated with the herb; then ſtrain it, and keep it ſtopt for uſe.

XXXVI. *An excellent ointment for burns and ſcaldings.*

Take of *ſaccarum Saturni* half a drachm, of the ſharpeſt vinegar four ounces; make a ſolution of the former in the latter, and add to this ſolution drop by drop, (often ſtirring or ſhaking them together) as much oil of elder, as will ſerve to reduce the mixture into the form of a nutritum or ointment.

XXXVII. *A ſlow but innocent way of making bliſters without cantharides.*

Take crow's-foot, and putting to a handful of it about half a ſpoonful of muſtard, beat them very well together to the conſiſtence of a poultis; put this to the thickneſs of one's little finger into a cover of a box cut ſhallow, and of about the breadth of the palm of one's hand (though this cover be leſs neceſſary than convenient,) and cutting a hole of the wideneſs of the box in a plaiſter of diapalma, or the like, to make it ſtick, you muſt apply it to the part, and let it lie on twelve or twenty-four hours, becauſe it works as well more ſlowly, than cantharides, as more ſafely and innocently.

XXXVIII. *A good medicine to raiſe bliſters.*

Take cantharides reduced into powder, and upon half an ounce of this put two or three ounces of good ſpirit of wine; let them lie together four or five days, that the ſpirit may acquire a good tincture; then filter it, and dip into it a piece of linnen cloth 6, 7, or 8 times double, and of the figure and largeneſs, that you deſire. This cloth being throughly wetted and covered with a melilot plaiſter, or one of diachylum, or ſome other, that will ſtick, to keep it on, muſt be applied to the part. At the end of five or ſix hours you may take off your plaiſter and the linnen cloth, and find your work done.

XXXIX. *To raiſe a bliſter without cantharides.*

The ſeed of *clemmatis peregrina* being bound hard upon any part, will in an hour, or at moſt two, have an operation like that of another veſicatory, as far as its contract reaches.

XL. *An uſeful medicine for coſtiveneſs.*

Take virgin-honey a ſufficient quantity, and mix exactly with it as much finely powdered *cremor tartari*, as will ſuffice to bring it to the conſiſtence of a ſomewhat ſoft electuary, of which the patient may take upon the point of a knife the bigneſs of an almond (more or leſs) as upon trial you ſhall ſee cauſe.

XLI. *For a cancer in the breaſt.*

Take of the warts, that grow on the hinder legs of a (ſtone) horſe, dry them gently till you can reduce them to a powder, of which you may give half a dram for a doſe in any convenient vehicle.

XLII. *A potent medicine for contuſions and divers other affections.*

Take alcohole of wine, and diſſolve in it as much pure camphire, as you eaſily can, and keep it very cloſe ſtopt, till you have occaſion to uſe it. Then moiſten throughly with it ſome thin pieces of linnen or flannel, and apply them lukewarm; and likewiſe you may, with a rag dipt in it, apply it to the eye-lids, having a care, that none of it get into the eye itſelf, ſince there it would cauſe great ſmart. It may alſo be very uſefully applied to burns, and yet more to contuſions.

XLIII. *A tried medicine for chilblains.*

Take pretty thick parings freſhly cut off from turnips, and hold them to the fire, till they be very criſp; then apply them to the unbroken tumours or bliſters, as hot as the patient can endure it, and keep them on a competent time, and put on new if need require. They will cauſe the peccant matter to tranſpire, or otherwiſe waſte, without breaking the bliſters.

XLIV. *To make a very nouriſhing aliment, that hath recovered divers in conſumptions.*

Take eight or ten craw-fiſhes, (or, if they be not of the largeſt ſize, a dozen) boil them (after the blackeſt gut or ſtring is taken out) in barley-water, till they become very red; then take them out, and beat them long, ſhells and all, in a marble or glaſs-mortar, to a ſoft maſh, and in a preſs ſtrongly ſqueeze out the juice; which may be given either alone, or mixt with about an equal part of chicken-broth, or ſome ſuch convenient alimental liquor.

XLV. *A vulgar, but often approved remedy for a cold, eſpecially that affects the breaſt.*

Take a ſheet, or half a ſheet *pro re nata*, of brown paper, of as even a texture as you can get, and anoint it over evenly and very well with the eldeſt tallow, or candle-greaſe you can procure, ſo that the paper may be thoroughly penetrated by it: then cover it thinly with nutmeg, as you were to rub the ſpice upon a toaſt, and clap it warm to the pit of the ſtomach, that it may reach a good way, both above it and beneath it.

XLVI. *An experienced medicine for coughs.*

Boil good turnips in water, and having expreſſed the juice, mix it with as much finely powdered ſugar-candy as will bring it into a kind of ſyrup, of which let the patient ſwallow a little as ſlowly as he can from time to time.

XLVII. *A good medicine for aſthmatic coughs.*

Take two ounces of oil of ſweet almonds freſhly drawn, and put them upon one drachm of flowers of brimſtone, keep them for a fortnight in digeſtion in a moderate heat, and then decant off the oil, or paſs it through a clean linen rag to keep back the brimſtone: of this liquor give a ſpoonful or two at a time.

XLVIII. *An eaſy medicine, which cured not long ſince a gentlewoman, that had taken much phyſic for a conſumptive cough.*

Take eight, ten, or twelve choſen raiſins of the ſun, and having ſlit them open, take out the little kernels, and ſtuff the raiſins with the tops or ſmall tender leaves of rue; and let the patient take them, either as they are, or in the form of a bolus, or the like, pretty early in the morning, faſting after them two or three hours at leaſt, if he cannot conveniently faſt until noon.

XLIX. *A potent medicine (for thoſe, that can bear it) to ripen coughs, and haſten the expectoration of phlegm.*

Take onions, cut them into ſlices, and fry them with freſh butter, as if you were to eat them; then take them out of the frying-pan, and boil them with new milk, until it be well impregnated with them, and they be made tender: of this mixture let the patient take a moderate quantity from time to time.

L. *An excellent remedy for a cough.*

Take of virgin-honey two ounces, of red-roſes warily dried and finely powdered half an ounce, of choice ſulphur very well ſifted two drams, of good benjamin reduced to fine powder one drachm; beat and mix all theſe very well; of this let the patient take the mixture from time to time.

LI. *A plaiſter to prevent corns.*

Take yellow bees-wax four ounces, verdigreaſe exactly powdered and ſifted one ounce, the caput mortuum of the ſkull of a man one dram. Incorporate them well with boiling a little, and make thereof a plaiſter according to art.

LII. *An effectual plaiſter for ſoftening and looſening corns.*

Spread a plaiſter of gum ammoniacum, (not too thick) without being diſſolved in vinegar, and applying it to the part affected, let it lie on, until it have ſufficiently done the deſigned work of emolition.

LIII. *A powerful (but ſmart) remedy for corns.*

Evaporate the ſtrongly expreſſed juice of radiſhes to the conſiſtence of a ſoft plaiſter, to be applied to the part affected, and ſhifted as often as it grows dry. *N. B.* It will ſometimes ſmart for a while at firſt, but afterwards it will do its work.

LIV. *A good remedy for corns of the feet.*

Take the yeaſt of beer (not ale) and ſpreading it upon a linen rag, or other cloth, apply it to the part affected, renewing it once a day.

LV. *An excellent remedy, that has cured many children of convulſive fits.*

Take two or three drops of (chymical) oil of roſemary, and put it into half an ounce of ſack in an ounce bottle; ſtop the vial, and let it be well ſhaked to make a whitiſh mixture of the liquors juſt before you give it. Or elſe in a half-pint bottle or vial, put four ounces of ſack, or ſome appropriated liquor, and drop into it forty drops of the forementioned oil; and whenever you are to give the medicine, ſhake the vial well ſtopt, and and preſently give of the whitiſh mixture a child's little ſpoonful.

LVI. *A ſucceſsful medicine for convulſive fits and hyſterical vapours (as they call them) or fits of the mother.*

Take the liver of a hare (if it hath been hunted, it may be the better) and hang it up in a dry place, till it be ſomewhat friable, having a care that it putrify not; of this reduced to powder, let the patient take two or three ſcruples at a time in any convenient vehicle.

LVII. *An excellent medicine for dry or convulſive aſthma's, and alſo for coſtiveneſs.*

GIVE at bed-time eight or ten grains of choice ſaffron, pulverized groſly in a little ſyrup or conſerve, as of violets, &c. to embody it with.

LVIII. *An excellent mixture for fits of the cholic, and ſome kinds of convulſions.*

TAKE one ounce of flowers of ſulphur, and as much ſugar-candy; grind them very well together in a glaſs or ſtone mortar, and upon this quantity drop thirty drops of oil of carraway-ſeeds, as much of orange, and as much of the oil of anniſeeds: incorporate theſe well, and of the mixture give about twenty or thirty grains for a doſe.

LIX. *An incomparable medicine for the cholic.*

THE yellow peel of oranges being reduced to powder, give from half a drachm to two ſcruples of it in any convenient vehicle.

LX. *To make good purging drink for the cholic.*

TAKE two ounces of rhubarb, four ounces of gentian, and a quart of good anniſeed-water; let the roots infuſe a long time in it, and give the patient about two ſpoonfuls at a time, as often as need requires.

LXI. *An almoſt ſpecific remedy for a fit of the cholic.*

TAKE about half a drachm of expreſſed oil of nutmegs, (uſually ſold in the ſhops for Eaſt-indian oil of mace) diſſolve this in ſome ſpoonfuls of good wine, which the patient is to take as hot as conveniently he can.

LXII. *An uncommon, but tried remedy for cholics (without much matter) and good in fits of the mother.*

TAKE good ginger dry, and inſtead of powdering it, cut it into as thin ſlices as you eaſily can: with theſe fill a tobacco-pipe, and take the ſmoak as you would that of tobacco. Do this twice, thrice, or four times a day, but eſpecially at bed-time, and in the morning.

LXIII. *An excellent medicine for convulſive cholics.*

TAKE of the volatile ſalt of pidgeon's-dung two or three grains, or ſomewhat more, (not exceeding five or ſix in all) mix theſe with a ſcruple or half a drachm of the ſame dung crude, but well and ſlowly dried, and finely powdered. Give this mixture for one doſe in ſome ſpoonfuls of any convenient vehicle.

LXIV. *For the cholic, or pains in the ſides.*

TAKE two balls of freſh horſe-dung, and infuſe them for twelve hours (if haſte require, three or four may ſerve the turn) in good white-wine, in a cloſe veſſel; then ſtrain the liquor, and let the patient take five or ſix ounces of it at a time.

LXV. *For the cholic.*

BOIL about one ounce of the ſeeds of the black ſtinging nettles in about a quart or more of good claret-wine; then ſtrain the decoction, and give of it a wine-glaſs full at a time, two or three times a day, or as often as need requires.

LXVI. *An excellent medicine for the cholic.*

TAKE of Dr. *Stephens*'s-water half a pint, plague-water half a pint, juniper-berry-water half a pint, powder of rhubarb two ounces; mingle theſe together, ſhake the bottle when you take any of it, and take about four ſpoonfuls at a time.

LXVII. *For the cramp.*

TAKE the leaves of roſemary, chop them very ſmall, and ſew them ſo in fine linen or ſarſenet, as to make a kind of garter of them to be tied about the patient's bare leg.

LXVIII. *To take off the pain of the cramp.*

TAKE of the ointment of populeon two parts, oil of ſpikes one part; mix them, and with the mixture anoint well or chafe the part affected.

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LXIX. *A remedy, by which an hydropical merchant was cured.*

GIVE about half a drachm or two ſcruples for a doſe of yellow tranſparent amber, twice or thrice a day in any convenient vehicle.

LXX. *An experienced medicine for a dyſentery, or bloody-flux.*

GIVE about three ounces of the juice of ground-ivy, mixt with one ounce of the juice plantane, once or twice a day.

LXXI. *For to ſtop a dyſentery, or bloody-flux.*

USE the powder of crepitus lupi, or fuſſballs, made up with ſome conſerve of roſes, or other convenient additament, into pills. Of this mixture give *in dyſenteria*, as much at a time, as contains from about a ſcruple, to about half a drachm of the powder.

LXXII. *An eaſy, but very often tried digeſtive, to be uſed inſtead of baſilicum.*

Take two ounces of good Venice-turpentine, and incorporate very well with it the yolks of two freſh eggs, and then add to it (at diſcretion) a little ſpirit of wine; with this dreſs the part morning and evening, laying it on thicker, if the part be near ſome nerve or other drier part, and leſs thick, if it be fleſhy or moiſt.

LXXIII. *A good medicine for incontinency of urine, and the beginning a diabetes.*

Cut off the necks of well-blown ſheep's-bladders; of the remaining membranes put up pretty ſtore one over another into a covered pot, where being dried gently, and yet ſufficiently, in a baker's oven, take them out, and pulverize them well. The doſe is as much as will lie upon a large groat, or ſmall ſix-pence.

LXXIV. *For a diarrhœa, looſeneſs, or flux of the belly.*

Mix up fifteen grains, or if the diſtemper be but ſlight, ten grains, of powdered rhubarb, with half a drachm of diaſcordium, and let the patient take it either going to bed, or early in the morning after his firſt ſleep.

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LXXV. *For a contuſion in the eye.*

Take the crumb of white-bread, and diligently incorporate with black ſoft ſoap as much of it, as will make a ſomewhat ſoft paſte; and then with your thumbs make a little cake (as it were) of it, and apply to the bruiſed part, the eye being firſt ſhut, and blind it ſo, that it may lie on for ſome hours, or a day, if need be. But this ought to be uſed with caution.

LXXVI. *An excellent medicine for clammy humours of the eyes.*

Take new milk, and let it ſtand, until it hath got a little cream upon it: then let the patient, when he is in bed, take up with his finger a little of the cream (and not of milk) and ſhutting his eye-lids, beſmear his eyes with it, having a care, that very little or none get into his eyes, becauſe it would make them ſmart; let the cream lie on, until the next morning, and in caſe the patient chance to wake in the night, he may, if he finds cauſe, lay on a little more, and waſh all off in the morning.

LXXVII. *A ſomewhat ſharp, but often tried medicine, to take off the pearl on the eye.*

Take of the juice of celandine, and mix with it about an equal part of pure honey; and of this mixture employ a drop, or at moſt two, at a time, letting it fall upon the part affected morning and evening.

LXXVIII. *An eaſy remedy for a recently blood-ſhot eye.*

Take a rotten apple, and as many tops of wormwood, as being well beaten together with it, will make a maſs of the conſiſtence of a cataplaſm; warm this a little, and put a ſufficient quantity of it into a thin and clean linen rag, and let the patient keep it upon the part affected all night, the next morning waſh it off with ſome red roſe-water, or the like liquor.

LXXIX. *To make a choice ophthalmick water to preſerve the eyes and ſight.*

Take of the diſtilled water of rue, celandine and vervain, of each one ounce; mix them, and infuſe in them two drams of crocus metallorum exquiſitely ground, for a week or ten days; then very carefully filter the infuſion, that none of the atoms of powder paſs thorough the liquor. Of this let fall into the eye a drop or two, morning and evening, having a care not to ſhake the glaſs, when you employ the liquor, leſt ſome unheeded duſt may have eſcaped the filter, and be raiſed.

LXXX. *For a ſlight ophthalmia, or blood-ſhot eye.*

Shake half a drachm of diligently prepared tutty into an ounce of red roſe-water, and drop it often into the eye.

LXXXI. *An experienced eye-water for an inflammation and tumour of the eye.*

Take of prepared tutty half an ounce, the water of white roſes and of frog's ſpawn, and alſo of the beſt canary wine (not diſtilled) of each two ounces, of aqua mirabilis half an ounce. Mix theſe well, and drop a very little at a time into the patient's eyes.

LXXXII. *An odd and often tried medicine for an ereſypelas.*

Take the blood of a hunted hare whilſt it is yet warm, and drench thoroughly in it clean linen rags, which are to be dried in the wind or free air, and then kept in a dry place for uſe: lay a good piece of linen thus ſtained upon the part affected, and either by binding it on, or covering it with ſome ſilken or other cloth, whoſe edges have ſome ſticking plaiſter, keep it from falling off, and renew it from day to day, if there be need. *N. B.* If it be grown too ſtiff with long keeping, you may ſoften it with a little ſprinkling of fair water.

LXXXIII. *An experienced water for ſharp and ſlimy humours in the eyes and eyes-lids.*

Take of prepared tutty half an ounce, prepared coral and pearl of each half a ſcruple, *trochiſci-albi raſ.* 5 or 6 grains, red roſe-water, and ſuccory-water, of each an ounce and a half; mix them well, and if you will have the medicine ſtronger, you muſt put 3 or 4 grains of aloes into it.

LXXXIV. *A choice remedy for an ophtalmia, or blood-ſhot eyes.*

Take of the juice of houſleek two parts, daiſies and ground-ivy, of each one part; mix theſe juices together, and to about 2 ſpoonfuls of the mixture, put 5 or 6 drops of clarified honey: let the juices depurate themſelves by reſidence, and then in ſome ſmall ſilver veſſel clarify them, and of this mixture let fall a drop or two into the eye 3 or 4 times a day. *N. B.* But if the inflammation be not ſo great, but there is more need of abſterſion, uſe more of the juice of ground-ivy, and leſs of that of houſleek.

LXXXV. *For a light ſtroke or contuſion of the eye.*

Take 2 ounces of betony-water, and three drops of clarified honey, mix them well together, and drop them into the eye 3 or 4 times a day; the compoſition muſt be made freſh every ſecond and third day.

LXXXVI. *A potent, but ſmarting medicine for things growing on the eye.*

Take white paper, and let it flame away upon a clean pewter platter, till there remain ſo much oil behind, as you think you ſhall need; blow off the cinders of the papers, and with a little of your ſpittle mixt by your finger with the oil, make up a kind of ointment; which, being taken up with a feather, is to be applied once or twice a day, as need ſhall require (and as the patient can well bear) to the affected eye; which courſe is to be continued, till the cure be compleated.

LXXXVII. *For hurts, that make the ſolution of continuity in the eye.*

Take 2 ounces of celandine-water, and put to it 2, 3 or 4 drops of good clarified honey, enough to give the water a faint taſte: with this dreſs the eye at leaſt twice (if not thrice) a day. But the mixture muſt be made freſh once in 2 or 3 days, or elſe it will grow ſouriſh.

LXXXVIII. *An excellent and very often tried eye-water, eſpecially for outward affections of the eye.*

Take of plantane-leaves 4 ounces, and of ſtrawberry-leaves as much; digeſt theſe for 24 hours in a pound of good white-wine; then diſtill them to dryneſs in a glaſs head and body in a *balneo Mariæ*. The liquor that is thus obtained, put into a very clean braſs (not copper) veſſel, and let it ſtand there ſome hours, till it have acquired a manifeſt, but not a very deep blue tincture; and then put to it (when poured on) an equal weight of white roſe-water diſtilled after the common way: ſhake theſe together, and let fall one drop into the internal corner of the eye, the patient ſtooping backward, and ſhutting his eye-lids for a minute or two, that the water may diſperſe on the eye, and that the quickneſs of the liquor, which may make him weep, may the leſs prejudice him.

LXXXIX. *To make a uſeful medicine for pain or itching in the eye-lids, or on that account in the eyes.*

Take half a ſpoonful of French barley (after the firſt water it was put into over the fire is caſt away) and boil it ſoftly for a little while in a pint of ſpring-water, ſeaſonably putting to it a good pugil of dryed damaſk-roſe-leaves. (*N. B.*) Sometimes you may add, if you pleaſe, a few red roſe-leaves, or melilot-flowers, or both.) With this liquor foment the part with a ſoft ſpunge for a pretty while, in the morning, and at night, having a care, that it be applied pretty hot, or at leaſt warm.

XC. *To make an excellent eye-water, for redneſs and light films, &c. in the eye.*

Make ſome lime-water, by pouring a gallon of ſcalding hot water upon a pound or ſomewhat more of quick-lime; ſtir them together, and after ſome hours, decant warily that, which is clear. And to a pound of this water put half an ounce (and no more) of choice verdigreaſe pulverized; and in a very moderate heat extract a tincture of a fine, but ſomewhat dilute, ſapphirine colour (but it ought not to be too deep.) Decant this very warily, and let a drop or two of it at a time fall into the eye, as often as need requires.

XCI. *An excellent remedy to ſtop a violent defluxion on the eye.*

Take red ſage and rue, of each 1 handful, a ſpoonful of fine wheat-flower, and the white of a new-laid-egg beaten to water; mix theſe very well, and ſpread them upon very thin leather or black ſilk, and apply it to the temples: it is to be about the bigneſs of a ſilver crown at leaſt.

XCII. *An excellent remedy for red eyes, made ſuch by a defluxion of a hot or ſharp humour.*

Take the tops of roſemary about one dram, and beat them up with one or two ounces of rotten pearmains or pippins, or, if thoſe cannot be had, with the like weight of the ſoft part of the ſame apples, that are ſound: and when by exquiſite beating, you have reduced theſe things to a cataplaſm, apply them (the cold being firſt taken off) to the part affected, binding it thereupon, and letting it lie all night.

XCIII. *An eye-water.*

Take houſe-ſnails, and beat them in their ſhells, and gratify them with about an equal quantity of juice of celandine; draw off the water in a cold or pewter ſtill (ſuch as is uſed for roſe-water) and keep the liquor, that will come over, cloſe ſtopt for your uſe.

XCIV. *The lady* Fitz-Harding's *eye-water, which lately cured an almoſt blind perſon, whoſe eyes looked like glaſs.*

Take 3 ſpoonfuls of white roſe-water, as much eye-bright-water, and as much ſifted white ſugar-candy, as will lie on a three-pence, and the ſame quantity of fine aloes ſifted and put to the water, and ſhaked together, and drop a few drops every night going to bed.

XCV. *A pericarpium, or wriſt-plaiſter, that oftentimes frees the patients from flying clouds in the eyes, and ſometimes leſſer ſpecks, eſpecially if recent.*

Take of rue, camomile, hemlock, each half a handful, of bay-ſalt 2 ſpoonfuls, 1 or 2 ounces of leaven; incorporate theſe well together, and make thereof *pericarpia*, to be applied to the patient's wriſts, and kept on, till growing dry, they become troubleſome.

XCVI. *An excellent medicine for hot defluxions on the eyes.*

Take of prepared tutty half an ounce, white roſe-water, and frogs ſpawn-water, carefully drawn in very good canary-wine of each 2 ounces, of *aqua-mirabilis* half an ounce; mix theſe well together, and let fall 2 or 3 drops into the patient's eye, eſpecially at bed-time.

XCVII. *An eaſy but uſeful eye-water to keep the eye cool and moderately dry.*

Take 2 ounces of ſuccory-water, half a dram of prepared tutty, ſhake them well, and keep them together for uſe.

XCVIII. *An often tried pericarpium, or wriſt-plaiſter for defluctions and fumes in the eyes.*

Take rue, camomile, hemlock, wormwood, of each half a handful, bay-ſalt pulverized about 2 ſpoonfuls, ſour dough about an ounce; mix all theſe together very diligently, moiſtening them from time to time with elder-vinegar to a conſiſtence fit for *pericarpia*, one of which is to be applied to the wriſt of that ſide, on which the part affected is, and to be renewed, if there be occaſion.

XCIX. *For a phylectena, or little tumour in the carneous tunicles of the eyes.*

Take the decoction of mucilages, that is proper for phlyctea's, and dreſs the eye from time to time to ripen the tumor: then open it with a lancet, and ſqueeze out all the matter; and laſtly, cleanſe and heal the part with honey. *N. B.* But when the tumor is beginning, or not great, you may, in want of the decoction of mucilages, dreſs the eye with the mixture of equal parts of the water of melilot, camomile, and betony.

C. *A plaiſter to ſtrengthen the eyes, and ſtop defluxions on them.*

Take of frankincenſe 2 ounces, *olibanum* and maſtick, each half a dram; mix theſe well, and reduce them into fine powder, of which a convenient quantity is to be melted and ſpread upon black ribbon, or ſome ſuch thing, with a hot knife or ſpatula, and ſo preſently applied to the temples.

CI. *An often experienced medicine for little ſtrokes or contuſions in the eye.*

Take betony-water 3 ounces, and five drops of clarified honey; mix them, and drop a little of the mixture from time to time into the patient's eye. *N. B.* Take ſuccory-water, crumbs of white-bread, a little ſaffron, and ſometimes a little honey, for ſharp humours in the eye-lids, and burns or ſmall ſpecks (of the eye;) 4 grains of roman vitriol to 4 ounces of water, of either roſe-water, ſuccory-water, or fennel-water, &c.

CII. *A good electuary to ſtrengthen the ſight.*

Take conſerve of borage and betony, of each an ounce and a half, Venice-treacle 2 drams, *ſpecies Dionyſi, dairrhodon abbatis, diatryon ſantalon*, of each half a dram, tartar vitriolate a ſcruple, diacorallion a dram and a half, oil of fennel 7 drops, ſyrup of violets and coral, of each a ſufficient quantity; mix and make an electuary.

CIII. *A choice medicine for an* ophthalmia ſicca.

Take of the leaves of fennel, hyſop, celandine, betony, and *carduus*, of each half a handful, or a whole handful; of linſeeds, quince-ſeeds, fenugreek, and fleawort, of each half a dram, of French barley 1 ounce: boil all theſe a little in 2 quarts of fair water, and half a pint of white-wine. Let the patient hold his head (well fitted with a napkin for the purpoſe) over the fumes for about a quarter of an hour.

CIV. *For a film, or other ſuch thing growing in the eye.*

TAKE of crude roch-allom 2 parts, turmerick 1 part, and refined ſugar 3 parts. Pulverize each of theſe ſeparately, then mix them exactly, and warily blow it into the patient's eye from time to time, as need ſhall require.

CV. *To make an excellent, as well as famous eye-water.*

TAKE celandine (the whole plant except the root) and having ſhred it, or chopt it a little, put it into a retort, and diſtill it in balneo. When all the liquor is come over, empty the veſſel, and put in it as much as the freſh plant, and diſtill the liquor from it to make it more ſtrong of the plant. Put this liquor once more upon new or freſh celandine, and diſtill in balneo as before; and keep this well-impregnated water cloſe ſtopt. It is to be outwardly uſed in the doſe of 2, or 3, or 4 drops at a time.

CVI. *A medicine for hurts in the eye.*

TAKE ſuccory-water and crumbs of white-bread, enough to bring it almoſt to a conſiſtence; then add a little ſaffron to tinge and quicken it, and ſometimes alſo you may put to it a little honey, to make it more cleanſing and healing. Apply it (if need be) with pledgets of flax to the part affected.

CVII. *A remedy, that hath cured the epilepſy.*

GIVE daily half a dram at a time of choice and very finely powdered amber, in any convenient vehicle for about 6 weeks together.

CVIII. *Elixir ſalutis.*

TAKE of the ſeeds of aniſe, ſweet fennel, coriander and parſley, of each 2 ounces; of liquoriſh ſcraped, waſhed and bruiſed, and choice leaves of ſenna, of each likewiſe two ounces; of raiſins of the ſun, rubbed clean and bruiſed, one pound; of elecampane-roots and guaiacum-wood, of each one ounce. Mix theſe ingredients, and pour on them 3 quarts of *aqua vitæ*, or Engliſh ſpirits (for brandy is too hot a liquor.) Let theſe infuſe together 48 hours. Then put them all in a hair-bag, and preſs them ſtrongly in an apothecary's preſs, and, if there be need, paſs what is ſtrained through an hippocras bag after the liquor is ſettled. Keep this in bottles well ſtopt in a cool place, and give of it two or three ſpoonfuls at a time, in the morning faſting, and, if need require, at bed-time.

CIX. *An experienced remedy for convulſions and epilepſies in children.*

TAKE about half a dram, or from one ſcruple or two, or ſomewhat more, of well-choſen and very finely powdered amber, native cinnabar 10 grains; mix them, and of this, ſweetened with ſome powdered ſugar, or other fit thing, that may give it a reliſh, let the patient take twice a day (at leaſt for moſt days) during ſix weeks, unleſs he fully recovers before that time: and, however, he is to take it for 2 or 3 days before each new and full moon, for ſome months ſucceſſively.

F.

CX. *An excellent drink in fevers, even malignant.*

TAKE a quart of ſpring-water, and having given it a walm or two, put to it one ounce at leaſt of harts-horn calcined to perfect whiteneſs, and when the mixture is cold, put to it 3 ounces of ſyrup made of the juice of lemmons; ſhake this mixture; when you will uſe it, ſhake it well, and let the patient take of it a moderate draught ſeveral times in the day and night.

CXI. *An uſeful drink in feveriſh diſtempers.*

IN a pint and a half of clear poſſet-drink boil about 1 ounce of cleanſed roots of dandelion, or piſs-a-bed, cut or ſliced very ſmall, till near half a pint be waſted, and then ſtrain it, and let the patient take half a pint, or the whole quantity, if he can, at a time.

CXII. *An excellent remedy for dyſenterical fluxes.*

TAKE good Venice-turpentine, and with a very gentle heat evaporate ſo much of it, that when it is cold, it may be but little ſhort of coagulation. This yet ſoft, but not fluid ſubſtance, incorporate with fine ſugar, enough to make it up into pills, whereof give in the morning faſting as many, as will amount from a ſcruple to half a dram, or 2 ſcruples, or a whole dram of turpentine, beſides the ſugar.

CXIII. *An uncommon, but experienced remedy for dyſenterical fluxes.*

TAKE the bone of the thigh of a hanged man (perhaps another may ſerve, but this was ſtill made uſe of) calcine it to whiteneſs, and having purged the patient with an antimonial medicine, give him 1 dram of this white powder for 1 doſe, in ſome good cordial, whether conſerve or liquor.

CXIV. *For the dyſentery and fluxes cauſed by ſharp humours.*

TAKE from half a dram to one dram of *mercurius dulcis*, and as much either of fine ſugar or ſugar-candy, and with ſome purgative or other, let the patient take it once a day, with care, that none of it remain in his mouth, or ſtick in his throat.

CXV. *An often tried medicine for fluxes of the belly, though bloody ones.*

Give for a doſe, in any convenient vehicle, as much powdered or grated pizzle of a hart or deer, as will lie upon an ordinary half-crown-piece.

CXVI. *An effectual medicine for dyſenterical and other fluxes.*

Take of a hare the ſkin, liver, gall, and all the parts, except the muſcles; and having dried them ſo far (and no further) as that they may be conveniently reduced to powder, give of this powder, from about two ſcruples to one dram, in any convenient vehicle.

CXVII. *An experienced remedy for ſharp fluxes of the belly.*

Take a pint of new milk, and diſſolve in it two ounces of loaf ſugar, and at length about the bigneſs of a walnut of good mithridate; give this mixture moderately warm for a clyſter, to be reiterated, if there be occaſion.

CXVIII. *To ſtop fluxes and whites.*

For fluxes you may, in divers caſes, give the patient from time to time a moderate quantity of a decoction of half an ounce of iſing-glaſs, in about a pint of new milk.

CXIX. *An eaſy medicine for fluxes, eſpecially thoſe cauſed by ſharp humours.*

Inſtead of butter take well-conditioned olive-oil, and thoroughly drench therewith a good toaſt, and let the patient eat it.

CXX. *For a bloody-flux.*

Take half an ounce of London-treacle, an ounce, or an ounce and a half of conſerve of red-roſes; mix them together with ſome ſyrup of clove-gilly-flowers, or ſyrup of citrons, and keep them thus mixed in a pot covered for your uſe. Take of this about the quantity of a walnut at night, and in the morning, for two days, faſting two hours before and after; intermit then a day, and take it again in the like manner.

CXXI. *A tried medicine for the falling down of the fundament.*

Take ſome ginger, and having careleſly ſliced it, put it in a little pan, heat it by clear and well-kindled coals, and let the patient receive the fume of it, caſt on by little in a kind of cloſe-ſtool, or ſome equivalent ſeat, where the lower part of the body may be well covered for about half a quarter of an hour at a time.

G.

CXXII. *A medicine for a light incipient gangrene.*

After having lightly ſcarified the part affected, apply as hot as the patient can well bear it, a cataplaſm made of ſtrong brandy, and the pith or crum of white-bread, ſhifting it three or four times a day, or ſomewhat oftener, if need be.

[*N. B.*] Some uſe turnips boiled, and made unctuous with a little freſh hogs-lard, to reſolve the hard tumors of women's breaſts.

CXXIII. *A choice anodyne clyſter.*

Take marſh-mallow-roots half an ounce, leaves of the ſame, mallows, mullein, of each one handful, camomile-flowers two pugils: boil them in a ſufficient quantity of water to ten ounces, yolks of two eggs, and oil of camomile an ounce and half: mix, and make a clyſter for eaſing pain.

CXXIV. *A ſlight, but often tried medicine for the griping of the guts.*

Take about a quarter of a pint of brandy, and having made a toaſt of bread (not too fine and white) throw it very hot into the liquor, and as ſoon as it is thoroughly drenched, let the patient take it out, and eat it hot; and this may be repeated, if there be need, two or three times a day.

CXXV. *An often tried remedy for the gripes in little children.*

Take of oil of nutmegs, and of wormwood, of each a little quantity, mingle them well, and with the mixture a little warmed, anoint the patient's navel, and the pit of the ſtomach.

CXXVI. *To make an excellent gargle.*

Take ſix ounces of ſcabious-water, one ſpoonful of muſtard, one ſpoonful of honey, and one ſpoonful of vinegar; grind all theſe very well together in a marble or glaſs mortar, till you have reduced them to a liquid mixture, which is to be uſed as a gargle.

CXXVII. *A choice gargle for a ſore throat.*

To four ounces of plantane-water add three or four ſpoonfuls of red roſe-water, and mix very well with theſe the white of an egg beaten to a glair or water: ſweeten this mixture with a ſmall ſpoonful of white ſugar-candy, or, in want of that, as much very fine loaf-ſugar. Let the patient gargle this as often as need requires.

CXXVIII. *An experienced medicine for a gonorrhæa.*

Take two ounces of ripe laurel-berries, and infuſe them for a day in a quart of good white-wine: of this let the patient drink about two or three ſpoonfuls twice a day for a pretty while together; only once in three days (or thereabouts) intermitting, that he may take ſome gentle purging medicine.

CXXIX. *For a gonorrhæa.*

Take choice maſtic a ſufficient quantity, and having very finely beaten and ſearched it, take about half an ounce of it at a time in the yolk of a new-laid egg, waſhing it down, if it be thought needful, in any convenient liquor.

CXXX. *An excellent remedy to take off the pains of the gout.*

Take minium or red-lead ground fine, half a pound, oil of earth-worms one pound, or a ſufficient quantity: boil them to the conſiſtency of a hard or ſolid emplaſter, without burning: afterwards add of camphire two ounces, diſſolved in oil of earth-worms, ſo much as may make an emplaſter of a juſt conſiſtency.

CXXXI. *An excellent ointment in the gout.*

Take Barbadoes tar and palm oil, of each a like quantity; melt them together in no more fire than is needful to make them incorporate well; with this mixture warm, the part is to be anointed, and warily chafed.

CXXXII. *A ſlight, but effectual medicine to appeaſe gouty pains.*

Take linſeed well conditioned, and, with a little water, beat them in a marble or glaſs mortar, rubbing them very well, that the medullary part may be ſeparated in ſome meaſure from the huſk, and may make the water conſiderably white. In this liquor dip clean rags, and when they are thoroughly wetted, apply them ſomewhat warm to the part affected, ſhifting them, if need be, once in an hour, or at moſt in two.

CXXXIII. *A ſpeedy remedy to take off arthritic or gouty pains.*

Take good ſpirit of *ſal armoniac*, and with a feather dipt in it moiſten gently all the part, or parts affected.

CXXXIV. *A medicine, that almoſt preſently appeaſes the pains of the gout.*

Take of black ſoap four ounces, choice wood-ſoot finely ſifted about a dram and half, and add to theſe about half the yolk of an egg: incorporate them diligently together, and ſpreading the mixture ſomewhat thin, apply it (the cold being firſt taken off) by way of cataplaſm to the part affected.

CXXXV. *A homely, but often tried medicine to appeaſe the pains of ſcorbutical running gouts.*

Take earth-worms cleanſed, and having filled an earthen pot with them, and luted on a cover very well, ſet it into an oven with a batch of bread, and let it ſtand there, till the oven be cold. Then take out the pot, and having removed the cover, you will find the matter turned into a groſs liquor ill-ſcented. Strain this with expreſſion, and keep it ſtopped for uſe, which is, to rub therewith the part affected with a warm hand once or twice a day. [*N. B.*] If the ſmell be offenſive, you may put to it a few drops of oil of *rhodium*, or ſome other odoriferous one, to correct it.

CXXXVI. *An excellent remedy for the gonorrhæa.*

Take of choice amber and of maſtich, both reduced to very fine powder, and very well mixed, equal parts, and of this mixture give half a dram at a time in a proper vehicle, or in a draught of chocolate; continue this for three weeks or a month, if need require, purging the day before you begin to take it, and once every week afterwards, eſpecially when you leave off the uſe of the powder.

CXXXVII. *To appeaſe the pains of the gout, and by degrees leſſen the fits.*

Take one part of *ſal armoniac*, and three parts of ſpirit of wine, neither of them too well rectified: ſhake them together, (and, if you pleaſe, digeſt them a while) and having dipt old, but clean linnen rags in the mixture, apply them to the part affected, ſhifting them now and then, as need ſhall require.

CXXXVIII. *To make an excellent cephalic, or head-powder, good alſo for the eyes.*

Take the leaves of flowers of betony, marjoram and damaſk-roſes; alſo the flowers of ſage and roſemary, all at diſcretion. To theſe add the powder of *lignum* aloes, and ſome ſeeds of *nigella Romana:* reduce all theſe to powder, to be uſed as a hair-powder, when the patient goes to bed.

CXXXIX. *An uſeful drink to be frequently employed to correct ſharp humours.*

Take two ounces of choice barley (Engliſh or French) well waſhed from its duſt and ſordes: boil this in a quart or more of ſpring-water till the grains begin to burſt; then ſtrain the decoction through a clean cloth, and let the patient uſe it at meals and other times for his ordinary drink.

CXL. *An experienced medicine for dulneſs of hearing, and hyſterical affections.*

The juice of red onions is excellent for diſeaſes of the ears, and for deafneſs in its beginning. [*N. B.*] Betony-roots alſo wonderfully prevail againſt all affections of the womb.

CXLI. *An experienced medicine for the pains of the hæmorrhoids.*

Take the ſole of an old ſhoe, worn by ſome man; that walks much, cut it in pieces, and burn it, not to white or grey aſhes, but to a fryable and tender coal; reduce this to impalpable powder, and then with a ſufficient quantity of unſalted lard, make it into an unguent, wherewith the part affected is to be anointed from time to time.

CXLII. *For the hæmorrhoids.*

Make a ſuppoſitory of hogs-lard or bacon, or inſtead of that employ gooſe-greaſe made up in the ſame form.

CXLIII. *For the hæmorrhoids.*

In the yolk of an egg, or a little of ſome convenient ſyrup or conſerve, give from half a dram, or two ſcruples, or one dram, or ſomewhat more of flower of brimſtone, once, or if the caſe be urgent, twice a day. The powder may be alſo given in milk to thoſe, that like it better than ſweet vehicles.

CXLIV. *A choice internal remedy for painful hæmorrhoids.*

Take about two ſcruples of choice ſulphur *vive*, and mix it with a little ſugar to make it reliſh, and give that doſe once, or at moſt twice a day.

CXLV. *A very choice medicine for the pain and tumors of the hæmorrhoids.*

Take freſh leeks (the whole plant) ſhred them ſmall, and fry them well with freſh butter, till they be fit to be brought to the conſiſtence of a cataplaſm or poultis, that is to be applied very warm to the part affected, and to be renewed from time to time, as need ſhall require.

CXLVI. *An uſeful medicine for the pain of the hæmorrhoids.*

Make up flower of brimſtone, and an equal weight, or a double, of fine ſugar, with a ſolution of gum-dragon, into tablets, that may weigh about a dram apiece: of thoſe, that contain the moſt ſulphur, you may give one twice a day, but of the other ſort much oftener, if need require.

CXLVII. *A choice remedy for the pain of the hæmorrhoids.*

Take *album Græcum*, or white dogs-turd, reduced to an impalpable powder, mix it up with a ſufficient quantity of gooſe-greaſe, and by grinding it well in a leaden mortar, reduce it to a black ointment, to be applied moderately warm to the part affected.

CXLVIII. *An experienced remedy for unbroken hæmorrhoids.*

Take calcined oyſter-ſhells, and incorporate them with as much honey, as will make up the powder into an ointment, with which the part affected is to be tenderly anointed from time to time.

CXLIX. *For the hæmorrhoids, a very ſucceſsful tried medicine.*

Take maiden-leeks (as ſome call thoſe, that grow without having been tranſplanted) and caſting away the green part, make of the bulbous part and a ſufficient quantity of whole oatmeal a caudle, whereof let the patient eat plentifully.

CL. *A choice drink for the pain of the hæmorrhoids.*

Take yarrow, and boil an handful of it in about a pint and an half of poſſet-drink, in a covered veſſel, till it be ſtrong of the plant; and of this decoction let the patient drink pretty plentifully from time to time.

CLI. *An excellent remedy for the pain of the hæmorrhoids.*

Take of maſtic, *olibanum*, aloes and myrrh, of each a like quantity; powder and mix them very well; then lay, or ſtrew a ſufficient quantity of this upon a pledget of lint or cotton, moiſtened throughly with ſpirit of wine over a few well-kindled coals, that the powder may melt, and be clapt hot to the pit of the ſtomach, or navel.

CLII. *A medicine for the pain of the hæmorrhoids.*

Take a quart, or at leaſt a pint, of new-milk, and boil it well for a while; and then taking it off the fire, preſently put it into a cloſe-ſtool in ſome open-mouthed veſſel, and let the patient ſit over the fume of it.

CLIII. *An excellent medicine to appeaſe the pains of the hæmorrhoids.*

Take two freſh eggs, and roaſt them pretty hard, then peel off the ſhells and mince them: to theſe add two pippins, the core being firſt taken out, that muſt be roaſted to pap; mix theſe, and incorporate them very well with the eggs, reducing all to a kind of cataplaſm, which is to be applied very warm, if not very hot, to the part affected.

CLIV. *A choice medicine for pains of the hemorrhoids.*

Take half a dram of good flower of brimſtone, and boil it a little in new milk, and let the patient take faſting in the morning both the liquor and the powder, for many days ſucceſſively. And, if need be, the like doſe may be taken between four and five in the afternoon. Alſo one may make up the like quantity of flores, with a little fine ſugar and gum traganth, into tablets or lozenges, to be taken inſtead of the powder and milk.

I.

CLV. *An experienced liquor to cure the itch in the hands or face, without mercury or ſulphur.*

Take a handful of the roots of elecampane, and as much of ſharp-pointed dock; ſhred them ſmall, and boil them in two quarts of ſpring-water, till the conſumption of a pint: then ſtrain the liquor, and with it let the patient waſh his hands, or other parts affected, once (or at moſt twice) a day.

CLVI. *An experienced magnetical cure of the yellow jaundice.*

Take the gall-bladder of a ſheep, and near the top, without emptying the liquor, make a hole, at which put in two or three drops of the patient's warm urine; then tye up the upper part of the bladder, and hang it in the free air, till it dry up, &c.

CLVII. *A homely, but not ineffectual medicine for the yellow jaundice.*

Give about half a dram of the white part of hen's dung, dried and mixed with a little ſugar, in a few ſpoonfuls of white-wine.

CLVIII. *A medicine almoſt ſpecific for the yellow jaundice.*

Take of clean filings of ſteel a ſufficient quantity, and, to make them grind the better, mix them with ſome loaf-ſugar; grind them long with great exactneſs, for in that conſiſts the chief ſecret of this medicine. Of this impalpable powder give about half a dram for a doſe (beſides the ſugar) and, if need be, give it twice or thrice a day in any convenient vehicle.

CLIX. *A ſpecifick remedy for the yellow jaundice.*

Take one part of good ſaffron dried enough to be rubb'd in a glaſs mortar into powder, and incorporate it well with four parts of choice turmerick. In the mean time take a handful of freſh ſheeps-dung, and let it ſteep in about a quart of ſtrong ale in a moderate heat, 'till the liquor be fully impregnated with the virtue of the dung. Then ſtrain it lightly through a linnen cloth, into a pint of it, or as large a draught within the limit, as the patient can well take; give about half a dram of the fore-mention'd mixt powder. This do in the morning faſting, and in the evening about bed-time, giving alſo another doſe the morning after the firſt.

K.

CLX. *The great medicine of a famous empirick for the king's-evil.*

Give, for a good while together, a pretty ſtrong decoction of devil's-bit.

CLXI. *To mitigate pains in the kidneys.*

Take oil of ſcorpions, and oil of bees-wax, of each a like quantity; mix them well, and with this mixture, moderately warm, anoint the pained kidney.

CLXII. *An effectual remedy for ſtoppage in the kidneys.*

Give in any convenient liquor about a dozen grains of ſalt of amber for a doſe.

L.

CLXIII. *A pleaſant medicine to appeaſe ſcorbutic pains in the limbs.*

Take liquid ſtyrax, ſpread it thin upon ſlink, or ſome very fine kids-leather; and keep it upon the part affected till it dry up of itſelf, or till the patient has no more need of it.

CLXIV. *An experienced, though ſimple medicine for a contracture produced by keeping of limbs too long in an undue poſture.*

Anoint well once or twice a day the part affected with dogs-greaſe, chaffing it in with a warm hand, and keeping the part warm afterwards.

M.

CLXV. *A good medicine to increaſe milk to thoſe, that give ſuck.*

Make pottage with lentils (which many diſtinguiſh not from vetches) and let the patient uſe freely of it.

CLXVI. *Another medicine to increaſe milk in nurſes.*

Take earth-worms, waſh them well, freeing them carefully from their excrements, and from all adhering earth and filth: then dry them ſo as they may not ſtink, and yet be pulverable. Of theſe, reduced to powder, give half a dram or two ſcruples for a doſe, in wine, or any other proper vehicle.

CLXVII. *A remedy, by which many dogs bitten by a mad-dog, have been all of them preſerved from running mad.*

Take three plants (*i. e.* roots and leaves) of that herb, which is called roſe-plantane, or by ſome ſtar-plantane; and having chopt it ſmall with a convenient quantity of butter, let the bitten dog take it the firſt day; the ſecond day give him five plants ordered as before, and the next day ſeven. *Lychnis Salamantica cluſ.*

CLXVIII. *A good remedy for divers affections of the* genus nervoſum, *or nervous ſyſtem.*

Take of the freſh roots of the male piony one ounce, of the ſeeds of the ſame plant two drams, and with a ſufficient quantity of the ſyrup of piony, or ſome conſerve of the like nature, beat them up into an electuary, (which is beſt done not long before you mean to make uſe of it) of which the patient may take the quantity of a ſmall nutmeg, or more, if need be, twice a day, and, if occaſion requires it, thrice.

P.

CLXIX. *Aloetic pills, that do ſcarce at all occaſion the piles.*

Take of the Frankfort angelical pills, and give of them one ſcruple or half a dram, or two ſcruples, or more for a doſe.

CLXX. *A medicine for the pain and tumor of the piles.*

Take the patient's own urine moderately warm, and with rags dipt in it foment for a while the parts affected, and then anoint them with *unguent populeum*. This do, if need be, three or four times a day; and if the tumors be internal, you may then inject a little of the forementioned urine.

CLXXI. *An excellent remedy for ſcorbutic and other pains in the limbs.*

Take red and unſophiſtical oil of petre, and anoint therewith from time to time the part affected.

CLXXII. *An eaſy, but excellent poultis to appeaſe pains and achs, even arthritic or gout pains.*

Take onions, and boil or ſtew them in water, till they be ſoft enough to make a poultis; then drain away the water, and beat them; and having ſpread them to a good thickneſs upon a linnen cloth, apply them as hot as the patient can well bear; let them keep them on all night.

CLXXIII. *To ſtrengthen a part weakened by ſublaxation.*

Spread *emplaſtrum divinum* upon ſoft leather, and apply it, keeping it on for ſome time.

CLXXIV. *A ſomewhat rough emetick, by which the French-pox has been often cured.*

Take good mercury ſublimate, and mithridate, or Venice-treacle, of each one ounce; mix them together, and put them into a quart of ſpring-water; ſet them in *balneo* to diſſolve in a cloſe veſſel; and of this liquor, well-ſettled, let the patient take about half a ſpoonful, or, if need be, a ſpoonful, but never above a ſpoonful and a half, in four ounces of ſmall ale warm, faſting in the morning, and once in the afternoon or evening, the ſtomach being empty. Every ſecond day intermit, and give a gentle purge.

CLXXV. *A choice medicine for the palſy.*

Take *ſarſaparilla* a pound and half, bark of *guaiacum*, China in chips, of each two ounces and a half: boil all in ſix pints of water to a conſumption of a third part: at the end add raiſins of the ſun ſtoned four ounces, liquoriſh bruiſed one dram, fat figs number twelve, boil and ſtrain it. Of this let the diſeaſed drink warm, as their ordinary drink.

CLXXVI. *For a weakneſs in the hands, ariſing from the palſy, or an ill-cured rheumatiſm.*

Take the tops of roſemary, and, bruiſing them a little, make them up into a ball of the bigneſs of a ſmall orange, or a large walnut with the green huſk on. Let the patient often roll one of theſe balls between his hands, and for divers hours in a day graſp one of them in the hand affected, that it may grow hot there, and tranſmit its effluvia into the part. Continue this courſe as long as the diſtemper requires.

CLXXVII. *A choice external remedy for paralitic affections.*

Make a ſtrong decoction of roſemary-leaves (or flowers, if the ſeaſon afford them) and let the patient hold the part affected for a good while at a time in the liquor kept very warm. If after ſeveral trials this medicine prove not effectual enough, take ten drops of oil of worms, and mix with it well four or five drops of oil of turpentine; and with this mixture, well warmed, anoint the part from time to time, or elſe let the patient keep the part for a good while together, for more than once or twice, if need require, in warm rain-water (to diſſolve the ſcorbutic ſalts.)

CLXXVIII. *To take off little pimples, or grating inequalities within the eye-lids.*

Take 1 ſpoonful of eye-bright water, 1 ſpoonful of plantane-water, and half a ſpoonful of good red-roſe-water; mix theſe, and put to them about 15 grains of choice tutty finely prepared; ſhake them together, and then let the powder fall to the bottom, and with the clear liquor moiſten the eye ſeveral times in a day, if it be found needful.

CLXXIX. *For the pleuriſy.*

Cut green broom-tops ſhort, and fill therewith a ſkillet or pipkin of a pint and a half; then fill it up with ale; boil it ſoftly, till it be waſted to 2 or 3 ſpoonfuls; it will look black like treacle, and be thick. When it is enough, and cold, add as much mithridate as a nutmeg, and mingle it well, and give it the party warm in bed, and let him ſweat 3 hours or more after it, by adding ſome clothes. If it help not at firſt, repeat it next day, or the ſecond, not to fail.

CLXXX. *An experienced (and by ſome good authors excellent) medicine for the pleuriſy.*

Take as many freſh balls of ſtone-horſe dung, as the horſe in good caſe may diſburthen himſelf of at one time; cover theſe, whilſt they are warm, with good white-wine; let them ſtand a little to act on one another, and then preſs out gently, through a clean linnen cloth, as much liquor or juice, as the mixture will readily afford; and of this (ſomewhat warm) give a moderate draught from time to time, as need ſhall require.

CLXXXI. *A very often experienced medicine for the ſmall-pox (eſpecially in children.)*

Take the little balls of freſh ſheep's-dung, and having freed them from ſtraw and duſt, and other things foreign to them, put an handful of them thus cleanſed into a quart of good white-wine, and in a veſſel well ſtopt let them infuſe in a moderate heat for a night, or till the liquor be well impregnated with the taſte and colour of them. Strain this infuſion, and give of it warm about a ſpoonful at a time, once in 2 or 3 hours, or oftener, if need require. *N. B.* In caſe of neceſſity, the infuſion may be much ſooner made, by putting into the wine a greater proportion of the ſheep's-dung.

R.

CLXXXII. *A ſucceſsful remedy for a kind of rheumatiſm, and a contracture of the limbs, that followed upon it.*

Take the inward bark (that which grows next the wood) of an elder-tree, cut or tear it into ſmall bits, and with them looſely placed fill about a third part of a bottle; then pour in as much ſmall ale or beer, as will fill up the remaining part of the veſſel; ſtop it well, till the liquor be ſtrong of the infuſion, and of this let the patient drink a good draught once or twice a day, or, if he can well bear it, let him take it as a diet-drink.

CLXXXIII. *An approved outward medicine to cauſe reſt without opiates*

Take of roſe-water 8 ounces, good wine 4 ounces, ſtrong vinegar 2 ounces; mix theſe well, and having warmed ſtupes in them, foment therewith the part affected, laying them on but moderately warm, but taking them off, when they begin to grow cold: this fomenting may laſt between a quarter and half an hour, before the patient ſhould compoſe himſelf to reſt.

S.

CLXXXIV. *A choice and diverſified medicine for the ſcurvy.*

From the freſh gathered tops of fir, a little bruiſed, abſtract ſpirit of wine, or at leaſt good nantes brandy, and with this liquor draw a deep tincture from other freſh tops, of which tincture reduce ſome part into an extract, whereof to form pills; keep theſe, the tincture and the impregnated liquor apart, to be employed ſeparately or conjointly, as occaſion may require.

CLXXXV. *For an excoriation, and for preternatural tenderneſs of any part of the ſkin.*

Take *unguentum diapompholigos*, and ſpread it thinly upon lint, which muſt be applied to the part affected, and kept on by a bandage or ſome ſticking plaiſter.

CLXXXVI. *To take off the heat and roughneſs of the ſkin, eſpecially on the lips.*

Anoint the part affected with freſh (or at leaſt not too ſtale) cream.

CLXXXVII. *To take out the marks of gunpowder ſhot into the ſkin or face, or elſewhere.*

Take freſh cow-dung, and having warmed it a little, apply it as a thin poultis to the part affected, renewing it from time to time, as occaſion ſhall require.

CLXXXVII. *An excellent medicine to ſtrengthen a weak ſight.*

Take eye-bright, penny-royal, rue, celandine, lovage, ſaxifrage, of each half a handful, blew-bottle-flowers, fennel-ſeeds, parſley-ſeeds, of each half a dram, grains of paradice 1 dram, hyſſop, organy, willow-leaves, each half an ounce, galingal 3 drams, ginger half a dram, cinnamon 1 dram, ſugar half an ounce. Let them be finely powdered, and very well mixt together. Take of this powder 1 ſcruple, or half a dram, every day with your dinner.

CLXXXIX. *A diſtilled water for ſtrengthening the ſight.*

Take roſemary-flowers, ſage, betony, rue, and ſuccory, of each 1 handful; infuſe theſe in 2 quarts of good ſack, diſtill them in a copper alembick. The doſe is a moderate ſpoonful.

CXC. *A choice medicine, which I have ſeveral times uſed for a light ſtroke or contuſion of the eye.*

Put to 2 ounces of carduus-water, or that of betony, 3 or 4 drops of honey; uſe it every 3 hours. (But have a care not to keep it above a day or two, leſt it grow ſour.)

CXCI. *A much commended powder to ſtrengthen the ſight.*

Powder of eye-bright 1 ounce, ordinary fennel-ſeed in powder half an ounce, powder of nutmegs half a quarter of an ounce, double refined ſugar 2 ounces. All theſe being finely powdered and ſifted, are to be mixt together, and taken as much as will lye on a ſhilling at a time, as often as you pleaſe. The powder is to be taken dry, and kept in a box cloſe ſhut in ſome dry place. This has done great cures in dimneſs of ſight, and rheums in the eyes.

CXCII. *To make a drink to be taken like tea, for ſtrengthening the ſight.*

To a quart of water ready to boil, put in half a handful of eye-bright, and then let the liquor boil for one walm or two, before you take it off to drink inſtead of tea.

CXCIII. *A rare water to ſtrengthen the ſight.*

Take clary, and diſtill it in a cold ſtill; and of the water let the patient take every morning, and if need be, every night going to bed, from 2 or 3 ſpoonfuls to 6, either alone, or ſweetened with a little ſugar; let him alſo, with the ſame water unſweetened, bath or waſh the parts affected in the morning, and at bed-time; and, if need be, once or twice more every day.

CXCIV. *An excellent external medicine to ſtrengthen the ſtomach.*

Take wormwood, mint, and mugwort, and by beating them well in a ſtone or glaſs mortar, make a cataplaſm, to be applied ſomewhat warm to the ſtomach, and kept upon it for a pretty while.

CXCV. *An often tried remedy to ſtrengthen the ſtomach, and alſo to take off griping pains in or near it. (It is good alſo for cold.)*

Take *emplaſtrum ſtomachicum* of the London diſpenſatory, and drop upon it 5 or 6 drops of oil of cinnamon, rubbing it well over with your finger, and ſo apply it to the patient's ſtomach; and after 3 or 4 days, or as ſoon as it grows dry, remove it, and having ſcraped the plaiſter, and warmed it on the wrong ſide, let fall ſome drops of the oil of cinnamon upon it, or more drops of the cordial ſpirit, and apply it again.

CXCVI. *An excellent plaiſter to ſtrengthen the ſtomach and cheſt.*

Take of cinnamon, nutmegs, cloves, and mace, of each a ſufficient quantity; powder them well, and ſtrew ſome of the powder all over the bottom of a deal box of a convenient length and breadth, and fit it with a cover to ſhut cloſe; upon this powder lay a piece of clean flannel well dried, and ſtrew it over thinly with ſome of the ſame powder; then lay on another piece of the like flannel of the ſame dimenſions with the former, and upon that likewiſe, if need be, a little more powder. This done, ſhut the box, till the time of uſe, and then take out one of the pieces of flannel, and having lightly duſted off the powder, lay it on the patient's breaſt, ſtomach, and belly, and let it lye on there for ſome days. When you perceive its virtue begin to languiſh, you muſt ſubſtitute for it the other piece of flannel, and put the firſt in the box to receive new virtue, and ſo proceed alternatively as long as you need the medicine, adding now and then ſome freſh powder, if neceſſity require. *Note*, that each piece of flannel ought to be long and large enough to cover the breaſt, and to reach from about the paps to the navel, or lower.

CXCVII. *For a recent ſtrain.*

Take a pint or more of claret-wine, and boil in it for a little while, in a cloſe veſſel, about a handful of red roſe-leaves, till the liquor be ſtrong of the plant. In this, well heated, dip a piece of linnen or flannel, and wringing out the moiſture, double it, and apply it hot to the part affected, uſing a fillet, or ſome ſuch thing to keep it on.

CXCVIII. *My lord* Bacon's *experienced medicine for a recent ſtrain or bruiſe.*

Take a good handful of freſh wormwood, and boil it in a ſufficient quantity of ſtrong ale to the ſoftneſs of a poultis; then take it off the fire, and when you apply it, which you ſhould do whilſt it is very hot, put to it a ſpoonful of good common brandy.

CXCIX. *A choice plaiſter for a recent ſtrain.*

Take equal parts of the plaiſters called *diapalma* and *oxycroceum*, and make of them a compounded plaiſter, to be ſpread upon thin leather, and applied to the part affected, and to be renewed, if need be, twice a day.

CC. *An approved medicine for a recent ſtrain.*

Apply ſeaſonably a cataplaſm made of bran boiled in good vinegar, till it be ſoft enough to make a poultis.

CCI. *A ſlight but choice remedy for a recent ſtrain.*

Take 2 ſpoonfuls of vinegar, and beat into it very well the white of an egg, and ſpreading it upon flax or tow, apply it to, and keep it on the part affected.

CCII. *A parable but excellent medicine in the fits of the ſtone.*

Take ſomewhat leſs than a handful of red chick-peaſe, or cicers, and boil them ſoftly in a quart of ſpring-water, till the liquor be red and well impregnated with the ſeeds: ſtrain this decoction, and ſweeten it with ſyrup of marſh-mallows, out of which all the ſtronger diureticks are left.

CCIII. *For the ſtone.*

Take a quart or half a pint of ſimple arſmart-water; ſweeten it with a little ſugar, or ſome convenient ſyrup, and aromatize it with a little nutmeg ſcraped, and give this mixture for 1 doſe.

CCIV. *For the ſtone and gravel in the reins and bladder.*

Take equal weights of common daucus-ſeeds, and of burdock-ſeed, and having mixt theſe together, put one ounce of the mixture to a gallon of ſmall ale, and let the patient uſe it as a conſtant drink.

CCV. *A good liquor, to uſe as drink in a long fit of the ſtone.*

Make poſſet-drink of three or four parts at moſt of milk, and one of white-wine. Into two quarts of poſſet-drink ſcrape or thinly ſlice a nutmeg and a half, or two nutmegs; add a little juice of lemon to your palate, and, if you pleaſe, ſweeten it a little with ſyrup of marſh-mallows. Take of this drink a pretty quantity at a time, and uſe it often in a day.

CCVI. *A good medicine for the ſtone.*

Take a pint or a quart of ale, ſomewhat new, ſweeten it with pure honey, and boil it to the conſumption of about one half, ſkimming it well from time to time. Then diſſolve in it the yolk of a new-laid egg; and let the patient drink a good draught of this mixture once or twice a day, until he find relief thereby.

CCVII. *A choice medicine in an actual fit of the ſtone.*

Take the decoction made according to the London diſpenſatory for the ſyrup of marſh-mallows, with this difference, that to the ſame quantity of water you muſt take but half the quantities of each of the ingredients. Let this corrected decoction be well clarified, and let the patient take it warm, ſix, eight, or ten ounces at a draught, from time to time, as need ſhall require.

CCVIII. *The ſtone, and the cure. Taken out of the hiſtory of* Barbadoes, *written by* Rich. Lygon, *Gent. p.* 118, 119.

After the ſtoppage of urine more than fourteen days, the following medicine did not only break, but brought away all the ſtones and gravel: and about three weeks after, the like pains returning, the ſame medicine did the like effect within ten hours after the taking thereof.

Take the pizzle of a green turtle (or tortoiſe) which lives in the ſea; dry it with a moderate heat; pound it in a mortar to powder, and take of this as much, as will lie upon a ſhilling, in beer, ale, white-wine, or the like; and in a very ſhort time it will do the cure. Theſe are to be had eaſily, both at the Caribbee and Lucaick iſlands, where theſe fiſhes abound.

CCIX. *A good medicine in pains of the ſtone, or cholick.*

Take half a pint of good ſallet-oil, and as much good ſack, (or, if that cannot be had, good claret-wine;) ſhake them very well together, and give them moderately warm for a clyſter.

CCX. *To expel the ſtone in a fit.*

Take crab's-eyes powdered, and diſſolve a large proportion of them in good white-wine-vinegar, and of this drink let the patient take from two ſpoonfuls to five or ſix at a time.

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CCXI. *An almoſt ſpecific remedy for the tooth-ach.*

Into a quart of red-wine (or at leaſt of claret) put one drachm of allum and another of acorns, a drachm and a half of galls, and half a handful of good dried roſe-leaves. Boil this to the conſumption of near half, and then take it from the fire and ſtrain it, and diſſolve it in a drachm and half of acacia cut into ſmall bits; and with this liquor, a little hot, you muſt waſh the part ſeveral times in a day.

CCXII. *An uncommon, but not unuſeful remedy for the tooth-ach.*

Let the patient lie on the ear, that is oppoſite to the part affected, and into the other ear drop two or three drops of the freſhly expreſſed juice of rue a little warm, and ſtop the ear lightly with fine black wooll or cotton.

CCXIII. *An odd, but very ſucceſsful external remedy for the tooth-ach.*

In the declining of the moon in *Auguſt*, take the fruit called hipps, *viz.* thoſe of the wild-brier, with all the furzey ſtuff, that grows upon it; and lapping it up in a piece of thin ſarcenet, tie it upon the arm, that is on the ſame ſide with the part affected, and keep it on as long as there is need.

CCXIV. *For the tooth-ach.*

Take a handful of red ſage, and a handful of clary; ſhred them ſmall, and beat them; ſprinkle them with May-dew; then ſtrain out the juice, put it in a glaſs bottle, and ſet it in the ſun in a window; and when you uſe it, put three drops into a ſpoon, and heat it over a candle blood-warm, and drop it into the ear, and let them eat a cruſt of bread wet either in broth or poſſet, and chew it upon the teeth, that ach.

CCXV. *An approved medicine for an aching tooth, that is hollow.*

Take two parts of common pepper ground to fine powder, and mix exactly with it one part of ſugar moderately fine over a gentle heat; form theſe into a ſmall pill of a ſhape and bigneſs fit for your purpoſe; and when your ſtuff grows cold, it will harden, and may be applied, when you pleaſe, to the part affected.

CCXVI. *An excellent remedy to faſten teeth.*

Take of burnt allum, acorns, of each one drachm, galls a drachm and a half, red roſes half a handful. Beat all theſe together, and make them boil in about a quart of good red wine, to the conſumption of about a fourth part. Then ſtrain the decoction, and diſſolve in the tranſmitted liquor of good achatia cut into very ſmall bits half a drachm. With this decoction the mouth is to be waſhed ſeveral times in a day.

CCXVII. *To faſten the teeth.*

Put maſtick finely powdered upon the end of an handkerchief, rub your teeth therewith twice or thrice in a day, and chew maſtic often. Alſo boil pomegranate-flowers with mint or maſtic, in red or claret wine; gargle or waſh your mouth often with it.

CCXVIII. *A medicine preſcribed to a great prince,* (Charles *the Firſt*) *to faſten the teeth.*

Take a pint of ſpring-water, and put to it four ounces of brandy; let the patient waſh his mouth with the mixture of theſe every morning, and twice or thrice a day beſides; and let him in the morning rowl for a little while a bit of roch-allum to and fro in his mouth.

CCXIX. *A good aſtringent liquor to faſten the teeth.*

To four ounces of claret-wine, or ſome other convenient menſtruum, you may put to diſſolve about four drachms of terra Japanica.

CCXX. *An excellent medicine to faſten the teeth in ſcorbutic gums.*

Take of choice bole-armoniac two drachms, choice myrrh (not lucid) one drachm, roch-allum crude half a drachm, claret-wine one pint; boil theſe ſoftly a little while together, and let the patient uſe twice, thrice (or, if need be, oftner) in a day.

CCXXI. *To faſten teeth made looſe by the ſcurvy.*

Anoint the parts affected with oleum myrrhæ made by deliquium, with whites of eggs, boiled hard.

CCXXII. *A lotion to faſten the teeth.*

In a quart of ſpring-water decoct for a while one ounce of the beſt terra Japanica reduced to groſs powder; and then having filtered the decoction, keep it cloſe ſtopt for uſe.

CCXXIII. *A good aſtringent liquor to faſten looſe teeth.*

In a pint of red wine infuſe about half an ounce of terra Japanica, until as much as will be diſſolved be taken up by the liquor. Decant it from the fæces (if there be need) and keep it well ſtopt for uſe.

CCXXIV. *An uſeful liquor to faſten the teeth, and prevent the tooth-ach.*

To a pint of ſpring-water put half an ounce of clean ſal armoniac, and with the ſolution of this ſalt let the patient waſh his mouth from time to time.

CCXXV.

CCXXV. *To make an excellent poultis to ripen tumors.*

Take eight ounces of (fat) figs, two ounces of white-lilly-roots, and two ounces of bean-flower (or meal:) boil theſe together in water, and reduce them to the conſiſtence of a poultis; which is to be ſpread to a good thickneſs, and laid warm enough upon the part, and ſhifted as often as it begins to grow dry.

CCXXVI. *An excellent medicine to relieve thoſe, that are troubled with tumors in the throat, and ſome other parts.*

To a quart of new-milk put a handful of mallow-leaves, with as much of the leaves of ſolanum, or nightſhade; ſhred them ſmall, let them boil, till the herbs be tender, as if they were to be eaten. Then put into the milk as much crumbs of white-bread, as, being ſtirred well with the other ingredients, will bring all to the conſiſtence of a poultis. This is to be ſpread upon a ſtay for the throat, or ſome other thing fit to be applied to any other part affected, and is to be laid on as hot as the patient can well endure it; and when it begins to grow cold, it is to be ſucceeded by freſh made very hot, and ſo long as the caſe ſhall require.

CCXXVII. *A medicine, that lately cured an obſtinate tumor of the knee, that had baffled ſome chirurgeons.*

Take a green colewort-leaf with red veins or ſtreaks, and having cut the ribs flat and almoſt level to the reſt of the leaf, bruiſe it with the haft of a knife, or ſome ſuch thing; apply it to the part affected, renewing it once or twice a day.

CCXXVIII. *A powerful and experienced topic for a ſore throat.*

Take two new-laid eggs roaſted moderately hard, and the pap of two well roaſted pippins; beat them well together, and add to them as much curds of poſſet made with ale. Having incorporated them all very well, apply the mixture very warm to the part affected, ſhifting it, if need be, once in five or ſix hours.

CCXXIX. *An approved remedy for a ſore throat.*

Take verjuice of grapes one ounce, good honey half an ounce, crude allum about a drachm and half, and ſea-ſalt half a drachm; powder the ſalts finely, and incorporate them very well with the liquors into the form of a kind of a liniment. In this dip a long feather, or a piece of rag tied about the end of a ſlender ſtick (as of liquoriſh,) and with it touch the part affected three, four, or five times; between each two times gargling with a mixture of plantane-water, and ſome red roſe-water.

CCXXX. *A choice external remedy for a ſore throat.*

Take millepedes, ſow's or hog's lice alive, and ſew them up between the foldings of a piece of linen, and apply them to the throat in the form of a ſtay, which is to be kept on all night.

CCXXXI. *An eaſy, but tried remedy for a ſore throat.*

Take bay-ſalt dried, and having pounded it, put it into the folds of a rag, in a ſufficient quantity to make a ſtay to be tied about the throat, and apply it over night as hot, as the patient can conveniently endure it.

CCXXXII. *A choice remedy for a ſore throat, eſpecially if inflamed.*

Take a little handful of the leaves of common mallows, and eight or ten good figs; boil theſe about a quarter of an hour in a pint of new milk, and let the patient uſe it very hot and often.

CCXXXIII. *A homely, but experienced medicine for a ſore throat.*

Take about one drachm of album Grecum, or white dog's-turd, burnt to a perfect whiteneſs, and with about one ounce of honey of roſes, or clarified honey, make thereof a linctus, to be very ſlowly let down the throat.

CCXXXIV. *A homely, but experienced medicine for a ſore throat.*

Into the leg of a worſted ſtocking, that has been long worn next to the fleſh, put in a ſufficient quantity of good ſea-ſalt exactly dried, or elſe decripated; and this ſalt being put in warm, if not hot, the ſtocking is to be tied about the patient's neck, and kept on all night. And if by the next day the diſtemper be not removed, you may apply freſh ſalt (in the proportion) in the ſame ſtocking as before, the night following.

CCXXXV. *A tried medicine for a ſore throat, cauſed by acid humours in the internal parts of it.*

Take half a handful of the leaves of common mallows, and boil them in about a pint of new milk near half an hour; then let it run through a clean cloth, and let the patient uſe it a little warm three or four times a day as a gargle; or elſe let him uſe it by holding it in his mouth, and letting ſome drops ſlowly ſlide down his throat.

CCXXXVI. *An often experienced remedy for tettars and the itch.*

Take flowers of ſulphur finely powdered, ginger and burnt allum, each alike, ſave that of the allum there muſt be ſomewhat leſs. Incorporate theſe with as much freſh butter, (without any ſalt) as will bring them to the conſiſtence of an ointment: with this anoint the part affected at bed-time, as hot as the patient can well endure it, and let it lay on all night; waſh it off in the morning with celandine-water well heated; and whilſt you continue the uſe of this medicine, take daily ſome cordial, to keep the noxious humour from being driven inwards. This will not fail to do the work.

CCXXXVII. *A choice medicine for a thruſh in young children, or a ſore mouth.*

Take an egg, and put out the meat, then fill it with the juice of red ſage, and ſet it on hot embers until it boil; then ſkim it, whilſt any ſkum doth ariſe. Then take as much allum beaten, as the bigneſs of a pea or bean, and half a ſpoonful of honey, and let this be put in the egg, and boil it a little, and ſo take it off; and when it is cold, rub the child's mouth as oft as you ſee cauſe.

CCXXXVIII. *An almoſt ſpecific medicine for a teneſmus.*

Mix balſam of ſulphur made with oil of turpentine, with linſeed-oil, or ſome other convenient oil, till the balſam be thereby ſo far allayed, that the patient may well endure it; and then let him dip his finger in it, and make uſe of it as a ſmall ſuppoſitory two or three times, or if need be, oftner in a day.

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CCXXXIX. *An excellent emulſion to be uſed in ſharpneſs of urine, eſpecially cauſed by bliſtering plaiſters.*

Take mallows two handfuls, gum Arabick two drams, brandy-water a ſufficient quantity; boil all to a quart, to which add ſweet almonds blanched one ounce, of the four great cold ſeeds, of each two drachms. Make an emulſion, ſtrain, and add two ounces of ſyrup of marſh-mallows, of which drink at pleaſure.

CCXL. *A powerful medicine for ſtoppage of urine.*

Fry chervil with a ſufficient quantity of oil of walnuts, and apply a cataplaſm made of it very hot to the navel (and if need be, to the *os pubis*, or ſhare-bone.)

CCXLI. *For a retention of urine.*

Take chervil, and with freſh hog's-lard fry it well, and lay it very hot upon the patient's navel, and all the adjacent parts, ſhifting it, if there be need, once or twice.

CCXLII. *An uſeful powder for ſuch as cannot hold their urine.*

Take root of the male piony, yellow amber, red coral, and choice gum Arabick, of each a ſufficient quantity; reduce them to fine powder, mix them well, and let the patient take of this mixture from 10 to 20 grains twice a day.

CCXLIII. *An eaſy medicine for ſharpneſs of urine, and for obſtruction of the menſes, and their flowing too much, if the diſtemper be not obſtinate.*

Give about half an ounce at a time of the newly expreſſed juice of ground-ivy in any convenient vehicle.

CCXLIV. *An old lithotomiſt's medicine for ſuppreſſion of urine, (given me by himſelf.)*

Give from about fifty grains to one drachm for a doſe of the *pulvis Holandi*, and if the neceſſity be very urgent, you may give from one drachm to four ſcruples, or a drachm and half, not neglecting in the mean while other proper remedies.

CCXLV. *For ſuppreſſion of urine.*

Give about a ſpoonful at a time of bruiſed muſtard-ſeed in any convenient vehicle.

CCXLVI. *A tried medicine for a ſuppreſſion of urine, that is not very obſtinate.*

Diſſolve half an ounce of choice Caſtile ſoap, in half a pint of white-wine, or ſome appropriated liquor; paſs the ſolution through a woollen filter, that the more greaſy parts may reſt behind, and the liquor paſs more clear; put to this five or ſix grains of ſaffron: divide it into two doſes, whereof one is to be given ſome few hours after the other, if the firſt do not operate well.

CCXLVII. *A ſpeedy remedy for fits of vomiting.*

Take a large nutmeg, grate off one half of it, and toaſt the flat ſide of the other, until the oily part begin to ouze or ſweat out; then clap it to the pit of the patient's ſtomach as hot as he can well endure it, and let him keep it on, whilſt it continues warm, and then, if need be, put on another.

CCXLVIII. *To make an aſtringent liquor, of great uſe in ulcers and (ſome) wounds.*

Boil two drachms of choice catechu, or Japan earth, in a quart of ſpring-water; pour off the clear, and with it by injection, or otherwiſe, dreſs the ulcers or wounds.

CCXLIX. *For outward ulcers.*

Take the green bark of oak, and chop it altogether, both inſide, and outſide, into very ſmall pieces. Upon theſe pour good lime-water freſhly made, and let them infuſe in it, till the liquor has acquired a deep tincture. With this dreſs the ulcer once, and, if need require, twice a day.

CCL. *The famous Scotch empirical medicine for a ſtubborn ulcer.*

Burn to aſhes, but not too much, the groſs ſtalks, on which the red colewort (not cabbage) grows, and with any fit additament, make thereof a cataplaſm to be applied to the ulcer, and ſhift it at reaſonable diſtances of time.

CCLI. *A remedy againſt the bitings of vipers, and other venomous creatures.*

As ſoon as ever one is bitten (for if the poiſon be diffuſed through the maſs of blood, the experiment may not ſucceed) a hot iron may be held as near the wound, as the patient can poſſibly endure, till it has, as they ſpeak, drawn out all the poiſon, which will ſometimes adhere like a yellowiſh ſpot to the ſurface of the iron.

CCLII. *A medicine againſt voiding of blood out of ſeveral parts.*

Take two drachms of henbane-ſeed, and the like weight of white poppy-ſeed; beat them up with an ounce of conſerve of red roſes, of which give to the quantity of a nutmeg or walnut.

Or, take the expreſſed juice of twelve handfuls of plantane-leaves, and ſix ounces of freſh comfrey-roots, well beaten together with a convenient quantity of fine ſugar. Theſe two medicines have wonderful effects to ſtop bleeding.

CCLIII. *A ſimple, but powerful remedy for freſh wounds.*

Take the juice of celandine, and dreſs with it recent wounds and cuts, inſtead of a balſam.

CCLIV. *To make a ſimple, but excellent balſam to ſtanch the blood of freſh wounds newly made, and to heal them ſpeedily.*

Take good Venice-turpentine, and in a limbeck, or ſome other convenient veſſel, diſtill off a good part of it with a very moderate fire, till there remains a thick ſubſtance, yet not like colophony, but of a liquid and balſamic conſiſtence. What you have diſtilled off ſet aſide for other uſes, for the remaining ſubſtance is what we now ſeek for, and is to be applied as a balſam both *per ſe*, and with pledgets and other helps.

CCLV. *An excellent wound-drink.*

Take hart's-tongue, liver-wort, wood-bugle, wood-ſage, wood-betony, ſouthern-wood, wormwood, alehoof, bugloſs, ſcabious, ribwort, white-bottles, mugwort, comfrey, mint, agrimony, ſtrawberry and violet-leaves, cinquefoil, daiſy-leaves, roots, and flowers, wild honey-ſuckles, wild angelica, avens, plantane, clowns, wound-wort, hawthorn-buds, oak-buds, and bramble-buds.

Gather theſe herbs in *May*, or as many as can then be had; the buds in *March* as ſoon as ever they put forth, before they come to leaves; meaſure them, and take equal quantities of them, and dry them ſeverally in the ſhade, and, when throughly dried, put them up in bags, and ſo keep them for uſe.

How to make the drink.

Take one gallon of ſpring-water, one pottle of the beſt white-wine, add to this two good handfuls of all the herbs, mingled well together being dried; but if green, then one good handful of each. Boil them in a pipkin or iron-pot to the conſumption of the half; then ſtrain it out, and put to the liquor a quart of honey, and let it boil again, and ſkim it, and when it is cold, put it up into bottles ſtopt very cloſe; then let the patient drink thereof morning and evening about a quarter of a pint at a time (ſome uſe only three ſpoonfuls at a time) faſting after taking of it one hour or two. Obſerve, the livewort is ever beſt to be put in green. If you make uſe of this for any ſore or ulcer in the body, lay any ſearcloth or plaiſter to it, of unguentum apoſtol. or minium, or ſuch like, as they uſe for wounds in the body, or a plaiſter of honey and wax.

This drink is effectual for ſores old or new, women's breaſts, putrified bones, cauſing them to ſcale; it is good for any ach in the ſtomach, for the king's-evil it hath cured, alſo cauſed bullets in the fleſh to come out, having long continued there. Sir *Jo. Mince* was healed by drinking of this, being wounded through the loins.

CCLVI. *A quick remedy for a ſmall and freſh cut, or wound.*

Let the patient ſpeedily plunge the hurt part into brandy, and keep it there for a while, until the pain, which will be excited, be extinguiſhed, or much abated: or, if the part be unfit for this operation, the liquor may be applied to it immediately with a ſoft ſpunge, *&c.*

CCLVII. *A good vehicle for divers remedies, and that it is itſelf uſeful againſt the jaundice, and worms in children.*

The diſtilled water of the huſks of walnuts is a very good vehicle in divers diſeaſes, particularly in jaundices; it is a cordial, and exceeding proper to be mixt with juleps in fevers.

vers. It is alſo an excellent antiverminary, or medicine againſt the worms, eſpecially for children.

CCLVIII. *A powerful medicine for white fluors (and the like diſtempers.)*

Take a pottle of ale, and ſhred into it two ounces of white ichthyocolla (iſinglaſs,) and in a looſely ſtopt veſſel let the liquor ſimper, till about half is waſted; ſtrain the reſt, and give of it two or three ounces at a time once or twice a day, as need ſhall require.

CCLIX. *A tried medicine for an ulcus uteri.*

Take of true and choice bitumen Judaicum, or aſphaltum, and having reduced it to very fine powder, let the patient take of it about a drachm at a time in any proper vehicle, once or twice a day.

CCLX. *An excellent water to preſerve the ſight.*

To half an ounce of celandine-water, and two drachms of ſuccory-water, mixt together, put two or three drops of clarified honey, and ſhake them all together, when you are to uſe them. Of this water let fall a drop or two into the eye once or twice a day. It will not keep above three or four days, eſpecially in ſummer, and therefore muſt be often renewed.

CCLXI. *A tried medicine for a whitloe.*

Take houſe-nails and beat them, ſhells and all, in a ſtone or wooden mortar, ſo long, till they be reduced to the conſiſtence of a cataplaſm; which apply ſomewhat warm to the part affected, and keep it on for 16 or 24 hours, renewing it then, if need be.

CCLXII. *A powerful diſſolving ointment for warts and divers tumours.*

Take May butter, and having melted it in a moderate heat, mix with it very diligently, but by little and little, as much oil of tartar *per deliq.* as will give it a ſenſible, but not a conſiderably ſtrong taſte.

CCLXIII. *An experienced remedy for bloody water.*

Take waters of the black alder, of mallows, of each 3 ounces, ſyrup of comfrey 1 ounce: mix them, and let the patient take 4 ſpoonfuls immediately; and 4 or 5 times a day.

CCLXIV. *To make a well experimented lime-water.*

Take freſh quick-lime 2 pounds, on which pour 2 gallons of water boiling hot; when they have ſtood together about 24 hours, pour off the clear, and into 1 gallon of this put of anniſeeds, liquoriſh, and ſaſſafras thinly ſliced, of each 4 ounces. Let them infuſe for 24 or 48 hours in a covered veſſel; then take a pound and a half of Smyrna raiſins (which ſome call great blue currans) waſhed and ſtamped. Let theſe infuſe for a few hours, and then paſs the whole mixture firſt through a ſieve, and then through a woollen bag. The doſe is about a quarter of a pint warm twice a day.

CCLXV. *An experienced medicine to correct the peccant humour in the king's-evil.*

Take half an ounce of cuttle-bone dried, till it may be finely powdered. Give this to the patient for 1 doſe.

CCLXVI. *An excellent and often tried clyſter in fluxes, eſpecially in ſharp humours, and ſome other diſtempers of the bowels.*

In a quart of new milk boil ſoftly 2 ſmall ſpoonfuls of groſly powdered rice, till it be brought to the conſiſtence of cream, then diſſolve it in 2 ounces of our ſuet of ſheep's-kidneys, and having ſtrained it to keep back the fibres, give it at once for a lavement.

CCLXVII. *A cure for ſchrophula's, and the king's evil.*

Take a handful of *paronychia folio rutaceo*, called rue whitlow-graſs, and by ſome felon-wort; boil it every morning in a quart of ſmall beer, ſtrain it, and drink it for your ordinary drink. It waſtes the peccant humour, appeaſes the pains, diſcuſſes the unbroken tumours, and heals the broken ones.

CCLXVIII. *Againſt epilepſies, or the falling-ſickneſs.*

Take of the powder of the true miſſeltoe of the oak, as much as will lye upon a ſix-pence, early in the morning, in black-cherry-water, for ſome days near the full moon.

CCLXIX. *A ſimple remedy for the ſtone.*

Take *Perſicaria*, or arſeſmart, as much as you pleaſe: diſtill it in a common roſe-water-ſtill, and give ſome ſpoonfuls of it in or before the fits.

CCLXX. *An excellent remedy againſt fluxes.*

Take unſalted butter, boil it gently, till a pretty part be conſumed, ſkimming it diligently from time to time, whilſt it ſtands over the fire: of this butter melted give now and then a conſiderable quantity, as the patient is able to bear it. This medicine was very ſucceſsful in *Ireland*.

A SUP-

A
SUPPLEMENT
TO
Mr. BOYLE'*s* COLLECTIONS
OF
Safe and Choice REMEDIES,
TAKEN
From his own Manuſcripts, added to the *Fourth Edition*, never printed before.

CCLXXI. *An excellent and often experienced medicine for convulſions, eſpecially in children.*

TAKE a pound of the true ſingle piony-roots, ſcrape and ſlice them as thin as paper into 3 pints of white-wine; infuſe it all night on embers in a pipkin cloſe covered and paſted up: In the morning ſtrain it out hard, and put in a quarter of an ounce of caſtor in fine powder, an ounce of the beſt ſpirit of caſtor, 30 grains of the moſs of a dead man's ſkull, and 30 grains of the ſkull itſelf: put all theſe into a ſtrong glaſs, that is very dry, and ſhake them half an hour with all your might. It may be given in a fit: a ſpoonful to a young clhid; to a man, or a woman a wine-glaſs. I uſually mix black-cherry-water with it.

CCLXXII. *The pills for the dropſy, that are much uſed by a perſon eſteemed for the cures he has done on that diſeaſe.*

Take *gambogia*, gum *ammoniacum*, of each a dram and a half, *diagridium*, and tartar-vitriolate a dram, with ſyrup of buckthorn, make a maſs for pills. Doſe from 15 grains to half a dram.

CCLXXIII. *An eaſy, but effectual medicine for the roughneſs of the lips, and to heal parts, that have the ſcarf-ſkin worn off.*

Take 2 parts of wax, and one of the freſheſt butter; melt and incorporate them over a gentle fire, and then let the mixture drop into ſmall cakes upon a glazed tile or a plate (whether pewter or ſilver) dipt in water, or elſe upon a piece of wetted white paper.

CCLXXIV. *A good and tried way to make an artificial wine, that is ſoon drinkable, and ſerves to keep the body ſoluble.*

Take a gallon of boiling water, and pour it upon 3 pounds of raiſins of the ſun ſtoned and well bruiſed; by ſqueezing and preſſing, get out the juice as thorowly as you can from the ſkins, *&c.* and having ſtrained, put to it a pound of brown ſugar-candy.

CCLXXV. *A not unpleaſant purge for children and delicate perſons.*

In the yolk of an egg diſſolve, by rubbing them very well in a clean glaſs or ſtone mortar, about 6 grains of choice reſin of jalap finely powdered, and, when the ſolution is made, incorporate with it little by little 2 or 3 ounces of ſuccory, or ſome other convenient water, which by this operation will be turned white, and make a kind of emulſion, which you muſt ſweeten at pleaſure, either with fine ſugar, or ſome laxative ſyrup, and give it in a morning faſting. *Cum cuſtodia.*

CCLXXVI. *An ingenious chymiſt's arcana for the ſtone.*

Take *borax* finely powdered, and make it up with ſome choice turpentine into pills, whereof 1 doſe ought to contain from a ſcruple to 2 ſcruples; waſh theſe down with ſome few ſpoonfuls of the tincture of *lignum nephriticum* made in water, or of cocheneal; or, if the caſe be urgent, you may give from

20 to 30 grains of the borax, and about a 5th part of myrrh; diſſolve in a couple of ſpoonfuls of the tincture of *lignum nephriticum.*

CCLXXVII. *An uncommon, bnt tried medicine to make a quick exfoliation of a carious bone.*

Take the thigh bone of a hanged perſon, (if it can be had of ſuch a body, elſe another may be ſubſtituted) and having burnt it to blackneſs, but not calcined it, reduce it to fine powder, which is to be carefully ſtrewed all over the part to be exfoliated, after ſome drops of chymical *oleum ſabinæ* have been employed to wet and ſoften the part, and make the powder ſtick well; this done, dreſs it up S. A. and it will ſeldom require a third, if it do a ſecond application.

CCLXXVIII. *An experienced medicine for madneſs* (mania) *not very obſtinate.*

Take 2 ounces of the berries of box, and infuſe them warm in a cloſe veſſel in a quart of claret, or red-wine for 48 hours; then decant the liquor, and put to it an equal quantity of the diſtilled water of vervain, and of this mixture let the patient take 6 or 8 ounces at a time, and compoſe himſelf to ſweat and reſt after it. This muſt be daily done for a pretty while together, if need requires.

CCLXXIX. *To prevent a gangreen upon a great pain, and to ſtrengthen the part.*

Take of melilot-plaiſter, and diapalma equal parts, and having melted and well incorporated them together, make thereof a thin plaiſter; which being prickt full of holes, is to be laid upon the inflamed or bruiſed part, firſt lightly ſcarified.

CCLXXX. *An excellent plaiſter to diſcuſs tumours, (even ſcrophulous) that may be reſolved, and ripening thoſe, that it cannot diſſipate.*

Incorporate exactly with the *emplaſtrum de ſapone* about a fourth part of *balſamum ſulphuris terebinthinati*, and uſe it as a plaiſter for the above-mentioned purpoſes. *N. B.* In want of this, you may employ *diachylon cum gummis*, renewing it once in 2 or 3 days.

CCLXXXI. *A parable medicine to drive away gravel and ſmall ſtones.*

Take the thick ſkin, that is found in the gizzard of a cock or hen, (but not a capon) and having warily dried it, till it be grown pulverable; give from a ſcruple to 2 ſcruples of it, in a draught of any convenient vehicle.

CCLXXXII. *An excellent remedy for whitloes on the fingers.*

Take a reddiſh, or at leaſt a blackiſh ſnail, of that ſort, that has no houſe or ſhell, and having beaten it in a mortar, that is no metalline, to the conſiſtence of a poultis, apply it to the part affected, renewing it, if need be, once or twice, after it has been kept on for ſome hours.

CCLXXXIII. *To make one ſpit out rheum, that ſwells the gums, and therewith cauſeth the tooth-ach.*

Diſſolve a ſpoonful of good muſtard in about a pint of French wine (claret or white,) and having warmed it a little, let the patient from time to time waſh his mouth with it, and hold it therein for a pretty while together.

CCLXXXIV. *To give eaſe in the fit of the gout.*

Take 3 parts of oil of turpentine, and 1 of chymical oil of ſpike; ſhake them well together; with this mixture anoint the parts lightly.

CCLXXXV. *An excellent eye-water to preſerve from rheums, eſpecially ſharp ones.*

Take 2 parts of celandine, and 1 of eyebright, and diſtill thence (*N. B.*) in balneo, a water or liquor, which you muſt put upon exquiſitively pulverized *lapis calaminaris*, and let them digeſt together in an exactly cloſed veſſel for ſome weeks, adding, before you uſe it, a third part of brandy, afterwards continue upon the powder as long as you employ the liquor.

CCLXXXVI. *To make an excellent and often tried medicine for the ſtone, whether of the kidneys or bladders.*

Take of pure white-wine, or rheniſh-wine, and of fennel-water, each one pint: into this mixture put half an ounce of wood-lice, alive and well cleanſed, of a middling ſize, and one lemon ſliced; let them infuſe in a veſſel well ſtopt, for three, four or five days, and then let the patient take about four ounces at a time twice a day.

CCLXXXVII. *An almoſt ſpecific remedy for the thruſh in children.*

Take houſleek freſhly gathered, cruſh it well between two plates, or otherwiſe, till you have ſqueezed out the juice, mix this with live honey, enough to make it ſomewhat ſweet, and then put to it as much finely powdered roch-allom, as will give it a little tartneſs; put ſome of this mixture with a quill, or a feather, down the patient's throat, as far as conveniently may be; if there be need, the part affected may be touched once more within an hour after.

CCLXXXVIII. *For the yellow-jaundice.*

Take rhubarb two drams, ſaffron, mace, of each a dram, hemp-ſeed one handful; bruiſe them, and put therein a quart of white-wine, and ſet it in a gentle heat to extract; then take mornings and evenings in an empty ſtomach, about a quarter of a pint; and when all is ſpent, pour on ſome more wine upon the ingredients, adding a little freſh rhubarb and ſaffron, and uſe it as before.

CCLXXXIX. *An almoſt ſpecific medicine for agues.*

Take reſin of ſcammony twelve grains, diaphoretic antimony, and cryſtals of tartar, of each eight grains; mix theſe carefully, and give them for one doſe, an hour before the fit comes.

CCXC. *To make a nephritic tincture, often found to relieve in the ſtone.*

Take oyſter-ſhells, and calcine them, till they be very white; of theſe take two parts, and one of rheniſh-wine-tartar; pulveriſe theſe apart very well, and then mix them diligently; pour on the mixture a little fair water, and let the ingredients work on each other, till the conflict be over; then ſtir the mixture with a ſtick, and pour on ſome more liquor; and when the effervеſcence ceaſes, put on a little more, and ſo proceed till no conflict be made. Evaporate to a kind of ſoft mucilage; digeſt this a while; decant the liquor and filter it, and you will have it, if it be not too flegmatic, of a fine red colour. Of this the doſe is from ten or fifteen, to thirty drops, or more, in any convenient vehicle.

CCXCI. *An almoſt ſpecific medicine for exulcerations in the kidneys.*

Take jet, and having reduced it to fine powder, give of it about half a dram for a doſe, in ſome good white-wine, in the morning faſting, and at bed-time, for ſome days together.

CCXCII. *An almoſt ſpecific medicine for the jaundice.*

With ſmall ale, or at leaſt not very ſtrong, draw a deep green tincture from freſh ſheep's-dung, and in a ſmall draught of this, give from half a dram to a dram of a powdered mixture, conſiſting of four parts of turmerick, and one of Engliſh ſaffron. This doſe may be given twice, or if need be, thrice a day, having a care, that the patient, whom it will diſpoſe to ſweat, keep very warm, and ſo whilſt the operation laſts.

CCXCIII. *An uſeful medicinal aliment for them, that are troubled with pains of the ſtone.*

Let the patient eat five or ſix onions roaſted, and ſparingly buttered, either in the morning faſting, or at meals, or at other times, if the caſe be urgent. [*N. B.*] The diſtilled water of onions is likewiſe of good uſe in the ſame diſtemper.

CCXCIV. *An experienced ointment for the worms in children.*

Take rue, wormwood, and ſabine, of each a ſufficient quantity, and with May, or other unſalted butter, or elſe with freſh hogs-lard, boil the herbs ſoftly, till you have brought the mixture to be very green; then ſtrain it, and pot it up for uſe: when you employ it, anoint with it firſt the pit of the ſtomach, and part of the cheſt a little above it, and then after a while rub it pretty well upon, and all about the navel.

CCXCV. *An often tried cataplaſm to break a ſore breaſt,* &c.

To the yolks of four eggs, take four ounces of live honey; mix them by grinding well together with a about half a pint of red or claret-wine, and apply this mixture as a kind of poultis to the part affected.

CCXCVI. *For an ague.*

Take the ſoot, that is in a baker's chimney, and muſtard, and rue, and white-wine vinegar, and ſallad-oil, and ſome white pepper and ginger, and make a poultis of it, and lay it to the pulſe of his or her arms, and let it lie for a fortnight or three weeks, if you will lay it on juſt before the fit come.

CCXCVII. *A very often experienced medicine for cankers in the mouth, and elſewhere.*

Take flowers of ſulphur one ounce, roch-allum, crude and finely pulveriſed, half an ounce; mix theſe very well together, and incorporate them with as much good honey, as will ſerve to bring the mixture to the conſiſtence of a liniment, to be applied from time to time to the part affected.

CCXCVIII. *An eaſy, but very effectual medicine to ſtop bleeding in wounds, and check ſome other hæmorrhages.*

Strew upon the part the powder of clear roſin beaten very ſmall.

CCXCIX *A very good drink for children, whoſe ſore eyes are ſuſpected to be ſcrophulous.*

Take of ground-ivy and arch-angel, (leaves, flowers and all) of each half an handful; pour on them a pint of boiling ſpring-water, and proceed as in making of coffee; let the patient drink a moderate cup of this two, three, or four times a day; but if you would have it ſtronger, you may put to a quarter of a handful of each of theſe, two or three drams of pile-wort-roots, which muſt be put to infuſe all night alone in the water, which, being thus impregnated, you muſt then boil, and be uſed as before.

CCC. *For ſcrophulous humours of children, eyes (and other parts.)*

Take figwort, and put two handfuls of it to a pottle of ſmall ale; of this give a quarter or half a pint at a doſe. The operation will be promoted by quenching ſeven or eight times in this liquor a gad of ſteel about eight or ten inches long.

CCCI. *Againſt a vertigo.*

Take of cyprus-roots two ounces, of aniſeed half an ounce; make of both a very fine powder, and take as much as you can lay on a ſixpence, in a ſpoonful of wine, beer or ale, when you go to bed. This medicine continued for five nights, (beſides other patients) cured a woman, who for divers years was troubled with a vertigo, and had uſed all ſorts of other remedies, preſcribed to her by London phyſicians, to little or no purpoſe.

MEDICINAL EXPERIMENTS:
OR, A
COLLECTION
OF CHOICE
REMEDIES
CHIEFLY
SIMPLE, and eaſily prepared: Uſeful in FAMILIES, and fitted for the Service of COUNTRY PEOPLE.

The PREFACE.

THE hon. ROBERT BOYLE, eſq; deceaſed, hath gratified the whole race of mankind by his public labours. The world may be divided into the learned and the unlearned part thereof. The former he much obliged by his elaborate diſcourſes on ſeveral ſubjects; the latter, which are far more numerous, he hath condeſcended alſo to oblige, by conſulting their health in the enſuing receipts. For, whereas the ordinary and inferior ſort of men, either have not ability (by reaſon of the tenuity of their eſtates) to reward phyſicians, or, by reaſon of the remoteneſs of their habitations, have not opportunity to conſult them; here they have remedies provided to their hands, and almoſt at their own doors; ſome of which the learned collector had experience of himſelf; and others were recommended to him by credible perſons, who had experienced their benefit in themſelves or their friends.

AND though thoſe ways of probation might be ſufficient to juſtify their publication; yet ſuch was the ſcrupulous care and zeal of this author, that he would not ſuffer them to ſee the light, till they had been firſt peruſed by ſome eminent phyſicians of his acquaintance, to whom he was pleaſed to commit the ſuperviſal of his medicinal receipts, both Galenical and chymical.

This century bears the name of parable receipts; becauſe they may be eaſily procured and prepared by country people, as their reſpective diſeaſes do require.

What comes forth in the name of Mr. Boyle, and is genuinely his, needs no farther recommendation.

His *ipſe dixit* is ſufficient, and ſuch are theſe preſcripts, as being found among his many other papers of like import, which in time may be publiſhed alſo.

I shall therefore only recommend them and their ſucceſs to the bleſſing of GOD, the alone giver, preſerver, and reſtorer of health.

J. W.

A
COLLECTION
OF
Choice and Safe REMEDIES.
The THIRD VOLUME.

I. *A good medicine for a newly taken, though violent cold.*

Take about four ounces of ſpring-water, and, in a convenient veſſel, put to it three leaves of good tuſſilago (colts-foot) and a pugil of maiden-hair, and a ſtick of liquoriſh for bigneſs and length like the furtheſt joint of the little finger: make the water warm, and when it is ready to boil, put in the fore-mentioned ingredients, (the liquoriſh being firſt ſliced and minced;) cover the pot well; let it boil for a few whalms; then take it off the fire, and having preſently ſtrained it, let the patient drink it hot like tea, he being already in bed: do this three or four nights conſecutively, or till there be no more need of the medicine.

II. *A good water for the eyes, that are foul, and pained by ſharp humours.*

Take prepared pearl and coral, *ana* one ſcruple, aloes cabalina, finely powdered three grains, red roſe-water and ſuccory-water *ana* one ounce; mix them well, and if you would have the mixture ſtronger, put in a very few grains of *trochiſci albi raſis* in very fine powder.

III. *A good medicine for pain of the teeth, that comes from rheum.*

Of the powder of white hellebore, put into a clean linnen rag, like a nodule, of about the bigneſs of the largeſt ſort of peaſe, or ſomewhat greater; and let the patient hold it between his teeth, with his head and face ſomewhat inclined, that the rheum may run freely out of his mouth.

IV. *An experienced ſternutatory to clear the head.*

Let the patient ſnuff up in the morning faſting, a ſmall ſpoonful, or leſs, of the clarified juice of *hedera terreſtris*, *i. e.* ground-ivy, or of beets, ſpitting out from time to time as much liquor as comes into his mouth.

V. *An often tried remedy for the dyſentery and ſharp fluxes of the belly.*

Give from fifteen to twenty grains of carefully made *mercurius dulcis*, incorporated with about two ounces of catholicon, or elſe with about one ſcruple of toaſted, or ſomewhat leſs of untoaſted rhubarb.

See Numb. (1.)

VI. *A good, though uncommon medicine for the dropſy.*

Take Virginian ſnake-weed a ſufficient quantity; and having cut and ſliced it very ſmall, infuſe it into a competent quantity of good ſack, till the liquor be very ſtrongly impregnated with the plant. Of this infuſion let the patient take three, four or five ſpoonfuls at a time (or more, if the caſe be urgent) when the ſtomach is empty.

See Numb. (2.)

VII. *An often experienced medicine for blood-ſhot, or inflamed eyes.*

Cut a new-laid egg boiled hard, into two halfs, (without taking out the yolks) and apply one of theſe conſiderably warm, but not too hot, to the part affected, and keep it on for ſome hours (ſix or eight, if it need ſo long.) Note well; to the ſame purpoſe you may apply, with good effect, a poultis made of a rotten apple, the cold being firſt quite taken off.

See Numb. (3.)

VIII. *An excellent remedy for a burn or ſcald in the eye.*

Take mucilages of quince-ſeed, flea-wort, linſeed and fenugreek-ſeed, of each one ſcruple; boil it very lightly in four ounces of betony-water, filter it, and apply it to the part.

IX. *A good and innocent dentrifice.*

Take maſtick and dragon's-blood, of each a ſufficient quantity; powder them, and mix them together, and let the patient uſe them as a dentrifice.

See Numb. (4.)

X. *To correct the laxity of the gums, and faſten the teeth.*

To a pint of red or claret-wine take about two drams of Japan earth, and having diſſolved ſo much as you can, pour off the clear, and let the patient waſh his mouth therewith from time to time.

XI. *An uncommon, but effectual fomentation for tumors accompanied with ſharp humours.*

To a gallon of ſpring-water put as much dried ſage, as you judge will afford a decoction ſtrong enough of the herb: into this, when it firſt grows hot, caſt about two ounces or ſome drams of Caſtile-ſoap, and let it diſſolve there till your decoction be completed: with this, and ſtupes, foment the part for a good while together.

XII. *A rare medicine for hyſterical affections, and ſeveral diſtempers of the* genus nervoſum.

Take one ounce, or a ſufficient quantity of volatile ſalt of harts-horn, which need not be exactly pure, and drop on it as much ſpirit of tartar, as will ſerve to ſatiate it, when the conflict is quite ceaſed. Digeſt the mixture for a while, that it may acquire a red colour, and keep it carefully ſtopt for uſe, and give four or five drops twice a day in any convenient vehicle.

XIII. *An often proved remedy to bring away what is, or ſhould not be left, in the womb of a puerpera, though it were part of a dead child.*

With the juice of ſheep's-ſorrel, and ſome of the ſtrong infuſion of the ſame herb (unpreſſed) in water, and a ſufficient quantity of ſugar, make a ſyrup; of which let the patient take about a ſpoonful, (a little more or leſs, as need may require, twice or thrice a day.)

XIV. *A tried medicine to take away corns.*

The parts being made ſoft with bathing and ſcraped, apply to the corn a plaiſter of ſhoe-maker's wax; but if the part be very tender, your plaiſter may conſiſt of equal parts of ſhoe-maker's wax and diapalma melted together, and ſpread ſomewhat thin.

XV. *To make an excellent ſtyptick powder to ſtanch blood.*

Take of white ſugar-candy, roch-allom burnt (but not too much calcined) and white vitriol, and pulverize them exceeding well, and mix them diligently, and having dipt pledgets of wax or lint, moiſtened with the white of an egg, into this powder, apply them to the orifices of the bleeding parts. Note well; it will do very well, after the dry ingredients are mixed, to grind them with as much whites of eggs beaten to water, as will make a paſte, which is afterwards to be throughly dried in the air, and then again reduced to powder.

XVI. *For a tooth-ach proceeding from defluxions or rheum from the gums.*

Diſſolve one ounce of choice Japan earth in a pint at leaſt of good red or claret-wine, and let the patient hold it in his mouth often, and a good while together.

XVII. *To prevent the fit of an ague, or cure that diſeaſe.*

Take of the ſcraping or gratings of the root of angelica half a dram, and of the flowers of antimony; mix them well, and let the patient take them at the uſual times.

Note here, that the flowers of antimony are not to be given inwardly in ſubſtance, but only in infuſion; for in ſubſtance they will hazard life, bringing firſt ſtrong convulſions, and then death. But you may make the medicine thus.

See Numb. (5.)

XVIII. *To make an often tried pericarpium for agues, eſpecially tertians.*

Take a handful and a half of freſh rue, half a handful of freſh ſage, a ſpoonful of bay-ſalt, a ſpoonful of good vinegar: beat all theſe very well together into an uniform maſs; which divide into two parts, and make thereof two wriſt-plaiſters to be applied at the uſual times before the fit; and to be renewed, if there be occaſion, to keep them on, till they grow dry and troubleſome.

XIX. *For the cholic.*

R. Orange-peels dried, till one may grate them to powder; and when they are pulverized, take about a ſpoonful of the powder at a time, mixed with a little white ſugar to ſweeten

ſweeten it, in or before ſome ſpoonfuls of any convenient vehicle.

XX. *An approved remedy for preſent deafneſs.*

Take of the breaſt-milk of a woman, that has had her firſt male-child ſome time before; and drop three or four drops of it warm, as it comes from the nipple, into the part affected.

XXI. *A choice medicine for burns.*

Take gooſe-greaſe (which the country-people call the leaf of a gooſe) and having ſoftly melted, and a little ſkimmed it, ſqueeze into it as much freſhly expreſt juice of ground-ivy-leaves, as, by continual ſtirring, will bring it to the conſiſtence of a green ointment. With this anoint the part itſelf affected, and afterwards lay on it fine rags well dipt in the ſame ointment.

XXII. *An external remedy, almoſt ſpecific for the leproſy.*

Take pomatum one ounce, flower of ſulphur one dram, *ſal prunellæ* half an ounce; and having mixed them very well together, from time to time anoint the part affected therewith, as long there is need.

XXIII. *For the head ach.*

Take green hemlock, that is tender, and put it in your ſocks, ſo that it may lie thinly between them and the ſoles of your feet; ſhift the herbs once a day.

XXIV. *For the hiccup (even in fevers.)*

Give two or three preſerved damſons at a time.

XXV. *A ſimple remedy for the cholic.*

In a draught of any convenient liquor, diſſolve about one dram of good ſalt of tarter, and let the patient take it for one doſe.

XXVI. *An experienced medicine to cleanſe the womb.*

Take a large white onion, cut it into ſmall pieces, and boil it in about a pint of water, or leſs, as if it were to be dreſſed for eating; and of this decoction give ſeven or eight ounces for a doſe, mixed with about half an ounce of freſh oil of walnuts.

XXVII. *To appeaſe the fits of a* furor uterinus.

Take the feathers of partridges (it matters not much from what part of the fowl) and burn them for a competent time under the patient's noſe.

XXVIII. *A very good ſyrup to ſtrengthen the ſight.*

Take about a ſpoonful of a ſyrup made of bettony-water and honey, twice, thrice, or four times a day.

XXIX. *An eaſy prepared, but uſeful drink for a beginning ſcurvy.*

To a quart of ſmall-beer (of ſix ſhillings *per* barrel) or ſmall ale, put over-night about a handful of ſcurvy-graſs-leaves, and let the patient drink this liquor at dinner for his ordinary drink for ſix or eight weeks together.

XXX. *A parable remedy for recent burns.*

Apply as ſpeedily as you can to the part affected, an onion, or more (if the burnt place be large) beaten to maſh.

XXXI. *For the tooth-ach.*

Apply a plaiſter of *carranna* to that part, that burns, between the bottom of the ear and the temples, on the ſame ſide, where the pulſation of the artery is the moſt manifeſtly or ſtrongly felt.

XXXII. *An excellent medicine, though not curative, for thoſe, that are tormented with the ſtone in the bladder.*

Take powder of comfrey-roots an ounce and half, marſh-mallow-roots three ounces, liquorice-powder two drams, ſeeds of daucus of Creet two drams, ſeeds of purſlane, of winter-cherries, of each half a dram, nutmegs two drams, ſaffron one dram, the ſpecies *diamargariton* frigid ſix drams, ſyrup of marſh-mallows four ounces; mix and make a ſoft electuary, of which let the ſick daily take the quantity of a walnut. It is profitable againſt the ſtone in the reins and bladder, but chiefly againſt the latter; as alſo againſt the ſtrangury, dyſuria, *&c.*

XXXIII. *To make a purging electuary, eſpecially for children.*

Take an ounce of choice rhubarb reduced to fine powder, and eight ounces of very good currans picked, waſhed, and rubbed dry; beat theſe together in a glaſs or marble mortar for near two hours. Of this electuary let the patient take about the bigneſs of a ſmall or large cheſnut in the morning faſting, and, if need be, at bed-time. If the caſe be very urgent, the medicine may be taken thrice in twenty-four hours.

XXXIV. *An excellent remedy for an inflammation in the eyes.*

Take a pippin (or other apple) cut it into two halfs, take out all the core of each of them, fill up the cavities with the tender tops of common wormwood, tye the half together, and roaſt the apple well; then beat it and the herb together to a kind of poultis, and apply it warm (but not hot) to the part affected, and bind it thereon, letting it lye all night, or, if you uſe it in the day-time, for ſix or eight hours.

XXXV. *An uſeful drink for the king's evil, and ſome affections, that have the like cauſe to it.*

Take a large handful (or two little phyſical handfuls) of the leaves of ground-ivy green, or (if the ſeaſon denies you them) well dried; waſh off the duſt with beer, not water, and put the herb into a gallon of ale-wort; when it is ripe for drinking, draw it out into bottles, and let the patient take a draught of it twice or thrice a day, or, if it be thought fit, it may be uſed at meals.

See Numb. (6.)

XXXVI. *An often experienced remedy to expel gravel, and provoke ſuppreſt urine.*

Kill a black cock or hen (rather than one of any other colour) take out the thick membrane or ſkin, that lines the gizzard or ſtomach; and having wiped it clean, dry it cautiouſly, ſo as it may be beaten to powder. With this mix an equal part, or half ſo much of choice red coral calcined: of this mixture, give from twenty or thirty grains, to forty or fifty grains.

See Numb. (7.)

XXXVII. *An approved remedy for the king's-evil.*

Set a quart of new-milk on the fire, till it juſt boils up; then take it off, and put into it two ſpoonfuls of the beſt honey, and ſtir it till it be diſſolved; and then ſet it on the fire again, and let it boil two or three walms: then divide it into four parts, and drink one part warm, early in the morning, another about ten of the clock, another about four in the afternoon, and the laſt a little before bed-time. Do this daily for two or three months, except you purge, which muſt be once a week, taking, (if a grown man) three quarters of an ounce of *caryocoſtinum* diſſolved in poſſet-drink: dreſs the ſores, if they run, with any drawing ſear-cloth, or a plaiſter of Burgundy-pitch. The medicine, though not very promiſing, is very famous by the many cures done with it by a charitable lady, of whoſe ingenious chaplain I procured this.

XXXVIII. *A good compoſition to ſtop a hollow tooth, and appeaſe the pain.*

Take two parts of fine ſugar (that of *Liſbon* does beſt) and one part of black round pepper, both finely powdered and mixed; put them into a ſilver ſpoon over two or three well-kindled coals; and when the ſugar begins to melt, take off the ſpoon; and whilſt the mixture is yet ſoft, form it into little grains for ſize and ſhape ſuited to the part affected.

XXXIX. *A plaiſter preferred by an antient phyſician, that often tried it, to the common ſoap-plaiſter.*

Mix about a dram of Caſtile-ſoap with one ounce of diachylum, and make thereof a thin plaiſter to be worn upon the part affected.

XL. *An excellent medicine to be uſed topically in gleetings.*

Take four ounces of ſpring-water [or plantane-water] and diſſolve in it about one ſcruple of the ſympathetic powder, or ſo much as will give it a ſenſible, yet but faint vitriol-like taſte: and of this mixture inject as much as is uſual of a ſmall ſyringe every morning and evening, as long as need require, directing the patient to retain the injected liquor as long as conveniently he can.

XLI. *An approved medicine in the biting of a viper.*

Take of white hore-hound, and apply the plant well beaten into the form of a poultis to the part affected, and give the patient a ſpoonful or two of the juice of the ſame herb to drink: it is alſo very good for the jaundice.

XLII. *An almoſt ſpecific medicine for the ſuppreſſion of urine.*

Take of *ſtœchas citrina* (in Engliſh, French lavender) and infuſe in a good heat two handfuls of the flowers in a pint of good brandy (not rectified ſpirit of wine) and of this infuſion, give about a ſmall wine-glaſs full at a time (diluted, if there be great need, with a ſufficient quantity of ſome appropriated liquor.)

XLIII. *For an ague, often tried.*

Boil yarrow (*millefolium*) in new-milk, till it be tender enough to have a cataplaſm made of it. Apply this to the patient's wriſts, juſt when the cold fit is coming on, and let it lie on the parts till the fit be gone; and if another fit comes, uſe freſh cataplaſms as before.

XLIV. *An uſeful plaiſter for thoſe that are troubled with vapours of the ſpleen, and ſhortneſs of breath, when it is a nervous affection.*

Take two parts of ſtrained galbanum, and one part of aſſa fœtida, and make thereof, according to art, a plaiſter of about the bigneſs of the palm of one's hand, taking care to ſeave a broad edge quite round, to prevent its ſticking to one's linen, and putting a pretty large piece of cotton in the middle, that the gums may not touch the navel, to which the plaiſter is to be applied.

XLV. *A ſlight, but excellent medicine to take off fits of the head-ach.*

Take about a handful of freſh roſemary, and boil it for a pretty while in a quart of common water; then almoſt fill it with a pint-pot (or rather a mug;) let the patient cover his head and face with a napkin, ſo that he may receive the ſteam as hot as he can well bear, and keep the veſſel there as long as he finds the ſteam ſtrong enough.

XLVI. *An eaſy and dry medicine for the itch*, præmiſſis univerſalibus.

Boil four ounces of clean quickſilver in about a gallon and half of ſpring-water, and let the patient take of this between a quarter and half a pint at a time, aromatizing it, if he pleaſes, with a little lemon-peel.

XLVII. *An eaſy medicine to purify and ſweeten the blood.*

Take the minera of Hungaria, or other choice antimony, and having ground it to very fine powder, without ſuffering it to touch any metal, give of this dry alcohole from ten grains to a drachm, giving it once a day, and (unleſs ſome particular reaſon diſſuade that time) let it be at dinner, that it may mingle with the patient's meat in his ſtomach.

XLVIII. *A cheap, but excellent medicine for ulcers.*

Take one drachm, at leaſt, of corroſive ſublimate finely powdered; diſſolve it in a quart of fair water, and let it lie there, if you have leiſure, four or five days (in a light digeſtion) that it may be throughly diſſolved. Then drop in it as much ſpirit of ſal armoniac, or as much oil of tartar *per deliquium*, as will precipitate it all: then filter it carefully, and keep it ſtopt for uſe, which is to imbibe doſſils or pledgets with it, and apply them to the ulcer twice or thrice a day.

XLIX. *An eaſy and innocent medicine for coſtiveneſs.*

Boil in as much broth as will ſerve to fill a large porringer, about half a handful of the leaves of common mallows chopped; and of this broth (being ſtrained) let the patient make the firſt part of his meal.

See Numb. 8.

L. *For the aching of a hollow tooth.*

Take oil of wax, and with it moiſten well a little cotton, and thruſt it up into the hollow tooth, letting it lie there, until the pain be ſufficiently aſſwaged.

LI. *An often tried medicine for the bloody-flux, being good alſo for pleuriſies.*

Give the weight of an eſcu d'or (or near one drachm) of the ſeed of *ſophia chirurgorum*, in Engliſh, flax weed, in two or three ſpoonfuls of any convenient vehicle, once or twice a day.

LII. *The cinnamon-drink, good in gripes and fluxes*, &c.

Take two ounces of calcined harts-horn, powder it, and boil it in three pints of ſpring-water till a pint be waſted; then take it off the fire, and infuſe in it an ounce and half of good cinnamon, ſetting it upon embers in a covered veſſel for about an hour. Then ſweeten it with ſugar to your palate, and drink about a quarter of a pint at a time. If taken for prevention only, a fourth part of the cinnamon will ſerve the turn.

See Numb. (9.)

LIII. *An eaſy, but uſeful remedy for redneſs of the eyes.*

Take a blanched almond, and about three grains of camphire, and, in a glaſs or marble mortar, incorporate them by wary grinding; and then add to them little by little two or three ounces of red roſe-water, ſtill grinding them, till the whole be brought to a kind of emulſion. Drop a little of this into the part affected.

See Numb. (10.)

LIV. *A moſt excellent balſam for any green wound of what nature ſoever.*

Oil of St. *John*'s-wort, and Venice-turpentine, of each a like quantity; ſet them over the fire in a gentle heat, half an hour or leſs, that they may incorporate. Then put them up, and keep it for uſe, as one of the beſt of balſams.

LV. *A good medicine for the ſuppreſſion of the menſes.*

Give for three mornings together, about the expected time of the monthly evacuation, a drachm, or drachm and half, or thereabouts, of the galls and livers of eels dried and made into powder.

LVI. *An experienced remedy to prevent apoplectic fits.*

Make at the croſſing of the ſutures an iſſue with diapalma and oil of vitriol, and keep it open the ordinary way.

LVII. *To dry up, or correct the humour, that makes ſcrophulous ulcers.*

Take of the bone of the cuttlefiſh, and having reduced it to an impalpable powder, give about one drachm of it at a time in any convenient vehicle.

LVIII. *An effectual medicine for a recent ſtrain.*

Take a handful of wormwood-leaves, and boil them in ſtrong ale, till the conſumption of about a third, that you may reduce them to the form of a cataplaſm, which, when you take from the fire, you muſt ſtrengthen by putting into it two, or at moſt three of brandy, and apply it warm, renewing it, if need be, in 24 hours at leaſt.

See Numb. (11.)

LIX. *For a ſlight inflammation of the eyes, as alſo a hordeum growing on the eye-lid.*

Take freſh houſleek; and having pounded it very well to a kind of cataplaſm, cover as much as is needful of it, for example-ſake, to the thickneſs of an half-crown, or a crown-piece, in the fold of a rag or linen-cloth, that may be ſo applied, that the cataplaſm may reach the eye, and the reſt of the cloth be faſtened about the patient's head. Let the medicine lie on all night, and be taken off the next morning. Repeat this application two or three times, in caſe there be need.

LX. *For moſt aſthmatic diſtempers.*

Take of the roots of elecampane, thinly ſliced, one ounce, of the leaves of ground-ivy a good handful. Boil theſe in three pints of ſpring-water to a quart; then ſtrain the decoction, ſweeten it with a little live honey, and let the patient take it five, ſix, or ſeven ſpoonfuls at a time. (Note well, remember the efficacy of ſaffron in the ſame diſeaſe, as it is commended by Mr. *Ray*, in his catalogue of plants.)

See Numb. (12.)

LXI. *For an ague.*

Take of the bone called platella, of the knee of a dead man, and having reduced it to fine powder, give of it as much as will lie upon a groat or a ſix-pence, for one doſe, in any proper conſerve, or fit vehicle, at a convenient time (before the cold fit.)

LXII. *An experienced medicine to kill tetters.*

Take of flowers of brimſtone, ginger and burnt-allum, of each alike; mingle them well, and of this mixture incorporate as much with new unſalted butter, as is requiſite to bring it to the conſiſtence of an unguent. With this anoint the part affected, as hot as the patient can well endure it, and let it ſtay on all night, and the next morning waſh it off with celandine-water. But when the patient goes to bed, he is to take a doſe of ſome alexipharmical medicine, as *Gaſcoign*'s powder, treacle, *&c.* to keep the humour from being driven into the maſs of blood: he is alſo to bathe the part oftentimes in a day with the celandine-water.

LXIII. *To make a good powder for a gonorrhœa.*

Take of choice red coral, and of maſtick equal parts; reduce them ſeparately to fine powder; mingle them very well, and of this mixture give about thirty or forty grains for one doſe.

LXIV. *A choice medicine for a ſlight ſtroke, or bruiſe of the eye.*

Take two ſpoonfuls of fennel-water, or of betony-water, and drop into it three or four drops (or five at moſt) of good clarified honey: ſhake them well together, and uſe them twice or thrice a day. But you muſt have a care to make this mixture freſh once in four, or at moſt in five days, eſpecially in ſummer; for if it be longer kept, it will be apt to grow ſour.

LXV. *An often tried external medicine for an eryſipelas.*

Take the blood of a hare (it is beſt if killed by hunting in *March*) and if you can have it freſh, anoint the part affected with it; otherwiſe apply on it a linen rag, that has (though a good while ago) throughly imbibed the freſh blood of that animal, and dried in the air. But if the imbrued linen be too hard or ſtiff, it muſt be ſoftened with a little fair water, and then, the cold taken off, applied to, and bound upon the part.

See Numb. (13.)

LXVI. *An empirick's much boaſted remedy for the fluor albus, or whites in women.*

Make a ſtrong decoction of the herb alchymilla (in Engliſh, ladies-mantle) and let the patient drink of it about half a pint every morning faſting; and if the caſe be urgent, make an injection of the ſame plant, boiled until it be very tender, and let the patient make uſe of it from time to time.

See Numb. (14.)

LXVII. *An excellent water for ulcers, and ſores, (tried with great ſucceſs.)*

To a quart of ſpring-water, take one dram of mercury ſublimate finely powdered; and when it is quite diſſolved, drop into the ſolution, either ſpirit of ſal armoniac (which is beſt) or oil of tartar *per deliquium*, until you ſee, that no more will manifeſtly precipitate. This done, filter the mixture through cap-paper, and reſerve the precipitate for other uſes. The liquor, that paſſes, you muſt keep cloſe ſtopt in a glaſs vial; and when you will uſe it, you muſt dip linen rags in it, and being throughly wetted, apply them to the part affected, ſingle or double, more or leſs, as need requires. This application may be renewed twice, or (if the caſe be urgent) thrice a day.

LXVIII. *An experienced medicine for want of ſleep, proceeding from great heats in the head.*

Take the paleſt carrots you can get, and ſcrape a ſufficient quantity of them to afford ſcrapings enough to make a cataplaſm of about two fingers, or two inches broad, and of the thickneſs of a half-crown-piece of ſilver, or thereabouts. Let the patient apply this in a piece of double linen to his throat, ſo that it may reach to the jugular veſſels on each ſide, when he goes to bed, and let it lie on all night (for it will not eaſily grow dry;) if the firſt application do not prevail, it is to be applied the following night; and ſo a third and fourth time, if need require.

LXIX. *A parable medicine, that has cured very many, eſpecially children, and young boys and girls, of convulſive fits.*

Take of the powder (whether made by filing, raſping, or otherwiſe) of the ſound ſkull of a dead man, and give of it about as much as will lie upon a groat, made up into a bolus, with conſerve of roſemary-flowers (or any other, that is proper) to a young boy or girl: but in perſons more aged and ſtrong, the doſe of the powder muſt be augmented to double the quantity. The medicine muſt be given often, if neceſſity requires it: if the patient be a child, it will be uſeful to apply to the throat a kind of necklace, made of the roots of vervain cut into beads.

LXX. *An eaſy and experienced remedy for the piles.*

In four ounces of ſpring-water diſſolve about one drachm of ſalt of tartar, or as much as will give the liquor a manifeſt, but not ſtrong alcaliſate taſte; and apply ſoft rags dipt in lukewarm, or ſomewhat more, to the part affected, ſhifting it from time to time.

LXXI. *A ſucceſsful medicine for the fluxes of the belly.*

Take rice-meal, and mix with it about a fifth part of finely powdered and ſifted chalk; boil theſe in water, or, which is better, if it agrees with the patient, in milk, and make thereof a haſty-pudding, to be moderately ſeaſoned with ſugar and powdered cinnamon; and let the patient eat it at meals, and, if need be, at ſome other times.

LXXII. *An often tried remedy for corns.*

Take the juice of houſleek, and mix it up with about equal parts of the thick balm or yeaſt, that ſticks to the barrel, or to the clay, that ſtops it. Of theſe make a kind of plaiſter, which being kept upon the toe for a while, and then, if need be, renewed, will make the corn very ſoft, and eaſy to be drawn out and extirpated.

See Numb. (15.)

LXXIII. *A good medicine for burns and ſtanching of blood.*

Diſſolve in ſpring-water, or, which is better, rain-water, as much ſugar as will make it a ſtrong ſolution, and then with a ſufficient quantity of linſeed-oil, or oil of olives, beat up this liquor, until the oil on it be brought to the conſiſtence of an unguent, with which anoint the part affected, as timely as you can, renewing the application as often as need ſhall require.

See Numb. (16.)

LXXIV. *An approved medicine for the bloody-flux, being good alſo for pleuriſies.*

Give two or three ſcruples of hare's-blood beaten to powder for one doſe, to be taken in a ſpoonful, or two or three of mint-water, or any other fit vehicle.

LXXV. *A very often (though homely) experienced remedy, for dyſenterick and other fluxes.*

Take the freſh dung of a hog (and, if you can, whilſt it is yet warm) and boil in a porringer full of new milk as much of it, as may amount to the bigneſs of a walnut; and alſo an equal quantity of fine mutton-ſuet ſliced very thin: when theſe are well incorporated with the milk, ſtrain them well through a clean linen; and, if there be need, ſweeten them a little with loaf-ſugar. Let the patient take this warm, once or twice a day.

LXXVI. *A powerful ſtyptick to ſtanch blood, where it can be applied.*

Take the fine powder of *lapis hæmatites*, made by grinding it exactly well, with an equal or double weight of *ſal armoniac*: and of this high-coloured ſublimate put a little upon the orifices of the veſſel.

LXXVII. *For a ſlight redneſs of the eyes.*

Take of French barley half an ounce, and damaſk-roſes half a handful. Boil them but very little in a pint of ſpring-water, and with this moiſten the part affected.

See Number. (17.)

LXXVIII. *For the relaxation of the* uvula.

Take bluiſh peaſe, or, in want of them, white ones, and chew them very well, ſo as to reduce them to the conſiſtence of a poultis. Lay this warm upon the crown of the head, to the breadth and thickneſs of a five ſhilling-piece of ſilver, or ſomewhat larger, ſhifting it in the morning, and at bed-time.

See Numb. (18.)

LXXIX. *A powerful medicine to ſtop ſharp rheums.*

Take a dram of catechu, or Japan earth, and make thereof a decoction in five or ſix ounces of good white-wine, or elſe of ſome diſtilled water, or other liquor appropriated to the diſeaſe. Of this give two or three ſpoonfuls at night, and in the morning as much alſo, if need require.

LXXX. *The Frenchman*'s *famous eye-water.*

Take two or three ounces of the water of ſimple pimpernel, diſtilled in balneo, and put this into a little pot or porringer of roſe-copper; then put into it about the bigneſs of a hazel-nut, or a filbert, of ſtrong quicklime: cover the pot, and let the ingredients lie in it, till the liquor hath acquired a bluiſh colour. Then very warily pour off the clear, and add to it as much live honey, as will give a little, or but little taſte: uſe it after the wonted manner of ſuch waters; and if you find it too ſtrong, dilute it a little with water of the ſame plant, or good ſpring-water, which, for need, may be uſed from firſt to laſt, inſtead of the water of pimpernel.

See Numb. (19.)

LXXXI. *Eye-water.*

Take red roſe-water, plantane-water, of each an ounce; *tutia* prepared, half a ſcruple; *lapis lazuli* prepared ſix grains, red coral prepared five grains; mix, and make a *collyrium*, or eye-water

This dropped into the eyes, being firſt well ſhaken, cures inflammations of the eyes, provided there be no great foulneſs, nor ſcrophulous diſpoſition in the patient. It takes off the redneſs of the eye-lids; if, with a ſpunge dipt in it, the eye-lids be often wetted it takes off films very well.

LXXXII. *A ſafe and uſeful medicine to prevent dryneſs, and ſome other diſaffections of the eyes.*

Take of choice virgin-honey two ſpoonfuls, of ſuccory-water, or the diſtilled water, of each four ſpoonfuls; mix them, and in a very clean veſſel over a very gentle fire, let them evaporate (taking off from time to time any ſcum, that may ariſe) till the mixture be brought to the conſiſtence of a ſyrup (or of honey) keep this in a glaſs cloſe ſtopped, and make uſe of it, by letting fall a drop or two, or at moſt three of it, at a time, into the eye.

See Numb. (20.)

LXXXIII. *The medicine of a famous empirick for the ſtone.*

Take amber (clear or yellow) ſea-horſe pizzle, and nitre, of each a like quantity; (note well, in caſe of ulcerated kindeys, put half the quantity of the amber) and an eighth part of the nitre (of natural balſam.) Pulverize each apart, and make them up into pills with chios, (or at leaſt clean Strasburg turpentine) take five, ſix or ſeven pills (of about ten to an ounce) morning and evening.

See Numb. (21.)

LXXXIV. *An excellent medicine for fits of the mother.*

Take *ſagapenum* diſſolved in vinegar of ſquills, ſtrained through a ſieve, and again inſpiſſated or thickened, *ammoniacum* in like manner prepared, ſteel prepared, myrrh, *fæcula* of briony, of each half a dram, Engliſh ſaffron, *caſtoreum*, of each a ſcruple, *borax* two ſcruples, ſyrup of *ſtæchas* a ſufficient quantity; mix, and make pills of a convenient bigneſs to be ſwallowed; of which take three morning and night, with care.

LXXXV. *A choice medicine for the cholic.*

Take clean white chalk, and having dried it with a gentle heat, reduce it to fine powder; wet this powder with the expreſſed juice of camomile, and let it dry in the air, without the heat either of the fire or of the ſun. This done, wet it again with new juice of camomile, and dry it the ſecond time as before. Wet and dry it again the third time, and, if you pleaſe, the fourth time; and then reduce the dry maſs to fine powder again. Of this powder let the patient take at a time as much, as will lie upon a groat or ſix-pence, in ſome ſpoonfuls of wine, or other proper vehicle.

LXXXVI. *Troches of vipers ſucceſsfully uſed to cleanſe the blood, and to ſtrengthen weak patients.*

Take of vipers reduced to fine powder one ounce, diaphoretick antimony half an ounce, clear yellow amber two drams, of ſtarch as much as of all the reſt, and of ſugar as much as of ſtarch; make them to a fine paſte with ſpirit of wine, and then make them into ſmall cakes, whereof one may ſerve for a doſe.

LXXXVII. *An approved medicine for ſcorbutick gums, and to faſten the teeth.*

Take of white-wine a pint, of allum half an ounce, of juniper-berries, and of red ſage *and* one ounce: boil theſe together, till a quarter of the liquor be waſted; then put into the remaining part four ounces of honey, and let it boil till the ſcum be all riſen; then filter it, and put into it one dram of *balſamum vitæ*.

See Numb. (22.)

LXXXVIII. *A caution about the vitriolate eye-water.*

Take four grains of Roman vitriol, not more, to four ounces of diſtilled water, either of roſes, ſuccory, fennel, *&c.*

LXXXIX. *A good medicine for a light ſtroke, or contuſion of the eye.*

Take half an ounce of celandine-water, and ſhake well into it three or four drops of clarified honey, and let fall of this into the eye a drop or two, twice or thrice a day.

XC. *An excellent medicine for a ſtroke or bruiſe in the eye.*

Take of betony-water, and hyſop-water, of each one ounce, and in their mixture ſtir ſome blades of ſaffron, till the liquor be pretty well coloured, and no more. And laſtly, add to it four or five drops of clarified honey,

See Numb. (23.)

XCI. *An excellent remedy to take off films, and ſuch like things from the eyes.*

Take choice bole-armoniac, and reduce it to very fine powder, blow this gently into the eye, once, or at moſt, twice a day. But if the patient be ſubject to, or fearful of any ſwelling, heat, or diſaffection in the eye-lids, incorporate the powder with a little clarified honey.

See Numb. (24.)

XCII. *To ſtrengthen weak eyes ſubject to rheums.*

Take *lapis calaminaris* four ounces, roſe-water a pint; ſhake them well together two days. Then let it ſettle, pour off this water into a little vial, and drop of it in weak eyes, two or three times a day, *&c.*

XCIII. *A plaiſter to ſtrengthen the eyes, and ſtop defluxions on them.*

Take of frankincenſe two drams, olibanum and maſtick, *and* half a dram; mix theſe well, and reduce them into fine powder; of which a convenient quantity is to be melted and ſpread upon black ribbon, or ſome ſuch thing, with a hot knife or ſpatula, and ſo preſently applied to the temples.

XCIV. *An experienced remedy for ſharp and hot humours in the eyes.*

Into a quart of new milk, already boiling, put about two handfuls, or leſs, of green houſleek, freſhly gathered, and chopt ſmall, and let the milk boil on, till it will yield no more curd. Then ſtrain the green poſſet-drink, and let the patient take every day once or twice a pint (or as near that quantity as he can reach to) ſweetened a little, if need be, with fine ſugar. The drink may be beſt taken cold.

XCV. *An excellent fumigation for pains in the eyes, and over-great dryneſs of them, and when one fears the beginning of a cataract.*

Take of fennel, hyſop, betony, celandine, carduus, of each half a handful, or a handful; of the ſeeds of linſeed, quinces, fenugreek, flea-wort, of each half a dram, of French barley one ounce: boil theſe in two quarts of fair water, and half a pint of white-wine: let the patient hold his head over the fumes for about a quarter of an hour every morning.

XCVI. *For ſore eyes.*

Take crumbs of white-bread, half an ounce, coral and pearl prepared, tutia, white ſugar-candy, of each half a dram; powder of red roſes a dram and a half, flower of St. *John*'s-wort one dram; and with a ſufficient quantity of milk make a cataplaſm, or poultis, which ſpread upon linnen-cloth, and bind it over the eye.

XCVII. *For heavineſs, and pain in the eyes.*

Take flowers of melilot, of elder, and of marigolds, of each a ſmall handful, linſeed, ſeeds of fenugreek, flea-wort, cummin and quinces, of each half a ſcruple, French barley half an ounce, damaſk roſes half an ounce, ſpring-water a pint and a half; mix and make a decoction, with which foment the forehead, temples and eye-brows, being ſufficiently warm.

XCVIII. *For a dry inflammation.*

Take of betony, hyſop, rue, wormwood, vervain, as alſo, of ſage-flowers, and roſemary-flowers, of each of all theſe half a handful. (To which may be uſefully added, cummin-ſeeds, fennel-ſeeds, and carduus-ſeeds, of each a quarter of an ounce;) boil theſe a little in two or three quarts of fair water, and then let the patient hold his head for about a quarter of an hour over the ſteam of this decoction, making uſe of a napkin, to keep the ſmoak from diſſipating, and direct it to the eyes. A while after he may put into them, if it be thought fit, a little clarified honey.

Several neceſſary Notes explicating, illuſtrating, or enlarging ſome of the Heads in the Preceeding Volume.

Numb. (1.) *For the bloody-flux, or other fluxes.* See Page 504.

TAKE Japan earth, powder of rhubarb, each equal parts; of which give half a dram at a time every morning faſting.

Numb. (2.) *A good medicine for the dropſy.* See p 504.

Note, an infuſion of mechoacan in white-wine (an ounce and a half thin ſliced to a pint) being infuſed twenty-four hours, and drank of every morning for ſome days, is a moſt admirable thing, and if a little muſtard-ſeed be infuſed in it, it will be ſo much the better.

Numb. (3.) *A medicine for blood-ſhot or inflamed eyes.* See p 504.

There is no better remedy for inflamed eyes, than to waſh them every day ſeveral times with this. Take frogs-ſpawn-water a pint, ſalt of tartar a dram; mix and diſſolve, and waſh therewith.

Numb. (4.) *A good and innocent dentrifice.* See p 505.

But that, which exceeds all, is a fine powder of red coral, with which you may rub them two or three times a day, and then waſh them with water, in which *ſal prunellæ* is diſſolved.

Numb. (5.) *To prevent or cure an ague.* See p 505.

Take gratings of angelica-root, flowers of antimony, of each half a dram, choice canary three ounces; infuſe in a cold place for one or two days, and pour off the clear for two doſes: it is a ſingular good vomit for the cure of agues of all ſorts, being given in the morning faſting, four or ſix hours before the coming of the fit; and if it be not a quotidian ague, then on the intermitting day.

Numb. (6.) *An uſeful drink for the king's-evil.* See p 507.

There is no better thing in the world for the king's evil, than to give daily ſome ſpoonfuls of this following liquor. Take white-wine a quart, juice of pellitory of the wall a pint, ſpirit of wine half a pint, *ſal prunellæ* an ounce; mix and diſſolve, then pour off the clear, and ſweeten with white ſugar. Doſe ſix ſpoonfuls morning and night.

Numb. (7.) *An experienced remedy to expel gravel, and provoke urine.* See p 597.

Take the juice of onions two ſpoonfuls, white-wine half a pint or more; mix them for a draught. It gives preſent eaſe, and, if repeated for ſome time, in a ſhort ſeaſon cures.

Numb. (8.) *An eaſy medicine for coſtiveneſs.* See p 508.

A turpentine clyſter thus made is admirable to cauſe ſtools in a very great coſtiveneſs.

Take Straſburg-turpentine an ounce, yolk of one or two eggs; grind them well together, and put thereto a pint of fat mutton-broth, and exhibit it blood-warm.

Numb. (9.) *A remedy for gripes and fluxes.* See p 508.

A moſt excellent remedy for gripings is a tincture of corn poppy-flowers made with common ſpirit of wine: of this you may give from a ſpoonful to two ſpoonfuls, in ſpirit of opium half an ounce, mixt with black cherry-water four ounces. This gives eaſe upon the ſpot.

Numb. (10.) *A medicine for redneſs of the eyes.* See p 508.

If the redneſs be with a fierce hot rheum, it is from weakneſs of the eyes; and then the only remedy is to waſh them twice or thrice a day with brandy. There is no danger in it, nor will it ſmart much.

Numb. (11.) *An effectual medicine for a ſtrain.* See p 509.

Take comfrey-roots beating them to a pulp half a pound, powder of Japan earth four ounces, ſpirit of wine a ſufficient quantity, mix and apply it to the part.

Numb. (12.) *For moſt aſthmatic diſtempers.* See p 509.

Take juice of hyſop, choice honey, of each two pounds: mix, boil, ſcum, and make a ſyrup; of which let the ſick take four ſpoonfuls or more, morning, noon and night.

Numb. (13.) *An experienced medicine for an eriſipelas.* See p 509.

The blood of almoſt any living creature is found by many experiments to be a ſpecific againſt an eriſipelas, being often anointed on the affect, or cloth dipt in the ſame being laid moiſt thereon.

Numb. (14.) *A remedy for the whites in women.* See p. 509.

The beſt of remedies in this caſe (after due purging) is to give two, three, or four grains of laudanum, and to inject three, four, or ſix times a day this water.

Take ſpring-water two quarts, white vitriol, roch-allum, of each two ounces: being in powder, mix and diſſolve. Let it ſettle, and uſe only the clear.

Numb. (15.) *A tried remedy for corns.* See p. 510.

Take ammoniacum ſtrained, emplaſtrum diapalma, of each an ounce, arcanum corallinum half an ounce, white precipitate two drachms: mix them well together, and apply it only over the corn, being firſt cut as cloſe as it conveniently can be.

Numb. (16.) *A medicine for burns and ſtanching of blood.* See p. 510.

But for ſtanching of blood, there are but few medicines, which exceed the colcothar of vitriol, whether waſhed and freed from its ſalt, or not waſhed; it is but a common thing, but will do more than a thouſand much more ennobled.

Numb. (17.) *For a ſlight redneſs of the eyes.* See p. 510.

One of the beſt of remedies againſt redneſs and inflammation of the eyes, is often to waſh them with this water. Take frog-ſpawn-water a pint, common ſpirit of wine four ounces; mix them; waſh herewith five or ſix times a day; and at bed-time apply over the ſore eyes a cataplaſm of a rotten apple.

Numb. (18.) *For the relaxation of the uvula.* See p. 511.

This common medicine is found very ſucceſsful: the throat being firſt gargled with claret-wine, in which a little roch-allum has been diſſolved, as hot as it can well be endured; then anoint it with this. Take honey one ounce, powder of elecampane two drachms, pepper in powder half a drachm: mix them, and apply it thrice a day with your finger.

Numb. (19.) *A famous eye-water.* See p. 511.

Take red roſe-water a quart, aloes in fine powder, half an ounce; white vitriol, *vitrum antimonii*, *crocus metallorum*, of each ſix drachms; mix and digeſt warm a month; then uſe the clear water three or four times a day; it has ſcarcely an equal.

Numb. (20.) *A medicine to prevent running of the eyes.* See p. 511.

Take white-wine half a pint, diſſolve in it white vitriol two drachms; filter or ſtrain, and therein diſſolve choice honey two ounces; with this fill the eyes two or three times a day. It is good againſt moſt diſtempers of the eyes.

Numb. (21.) *A medicine for the ſtone.* See p. 511.

Take Straſburgh-turpentine two ounces; grind it well with the yolks of eggs, and then mix herewith this following ſyrup. Take water a pint and half, ſal prunellæ an ounce and half: mix, and diſſolve; and with honey a pound, boil it into a ſyrup, which add to the former mixture. Doſe two or three ſpoonfuls morning and night.

Numb. (22.) *A medicine for ſcorbutic gums, and to faſten the teeth.* See p. 511.

There is nothing faſtens the teeth better, than to waſh them with this mixture. Take claret-wine a pint, roch-allum half an ounce; mix and diſſolve, and then add thereto ſix ounces of ſtrong tincture of Japan-earth, made with common brandy.

Numb. (23.) *For a ſtroke, or bruiſe in the eye.* See p. 512.

Take celandine-water three ounces, ſpirit of ſaffron one ounce; mix them, with which waſh the eyes ſeveral times a day; and if the eyes be very ſore, red or blood-ſhot, after waſhing anoint them every time with a little pure virgin-honey.

Numb. (24.) *An excellent remedy to take off films from the eyes.* See p. 512.

Take powder of coral levigated one ounce, powder of pearls levigated three drachms, crab's-eyes levigated one drachm, virgin-honey two ounces; mix them, and anoint four or five times a day, but chiefly morning and night.

Numb. (25.) *A remedy for the king's-evil.*

Take roots of pile-wort a ſufficient quantity; bruiſe and boil them in hog's-lard, until they are criſp, after which preſs them hard out; and boil in the like manner as many more freſh roots, and preſs out again, doing it the third time; then keep the ointment for uſe, to anoint with morning and night.

Numb. (26.) *A remedy for the ſtone.*

Give every morning faſting, and every night going to bed, half a drachm of the powder of winter-cherries in a draught of parſley, or arſmart-water, or in a glaſs of white wine.

A
DISQUISITION
ABOUT THE
FINAL CAUSES
OF
NATURAL THINGS:

Wherein it is inquired,

Whether, and (if at all) with what Cautions, a Naturaliſt ſhould admit them?

To which are ſubjoined, by way of

APPENDIX,
SOME
UNCOMMON OBSERVATIONS
ABOUT
VITIATED SIGHT.

The PREFACE.

THERE are not many ſubjects in the whole compaſs of natural philoſophy, that better deſerve to be inquired into by Chriſtian philoſophers, than that, which is diſcourſed of in the following eſſay. For certainly it becomes ſuch men to have curioſity enough to try at leaſt, whether it can be diſcovered, that there are any knowable final cauſes to be conſidered in the works of nature; ſince, if we neglect this inquiry, we live in danger of being ungrateful, in overlooking thoſe uſes of things, that may give us juſt cauſe of admiring and thanking the author of them, and of loſing the benefits, relating as well to philoſophy as piety, that the knowledge of them may afford us: and if there be no ſuch things, we are more than in danger to miſpend our labour and induſtry, in fruitleſs ſearching for ſuch things, as are not to be found. And an inquiry of this kind is now the more ſeaſonable, becauſe two of the chief ſects of the modern philoſophizers do both of them, though upon differing grounds, deny, that the naturaliſt ought at all to trouble or buſy himſelf about final cauſes. For *Epicurus*, * and moſt of his followers (for I except ſome few late ones, eſpecially the learned *Gaſſendus*) baniſh the conſideration of the ends of things; becauſe the world being, according to them, made by chance, no ends of any thing can be ſuppoſed to have been intended. And on the contrary, † monſieur *des Cartes*, and moſt of his followers, ſuppoſe all the ends of God in things corporeal to be ſo ſublime, that it were preſumption in man to think his reaſon can extend to diſcover them. So that, according to theſe oppoſite ſects, it is either impertinent for us to ſeek after final cauſes, or preſumptuous to think we may find them. Whereſore, I hope I ſhall be excuſed, if, having been engaged by ſome ſolicitations, (wherewith it is needleſs to trouble the reader,) I did not decline to try, what the bare, but attentive, conſideration of the ſubject would ſuggeſt to my own thoughts. And though it was eaſy to foreſee, that by this means my friend might miſs of receiving in my eſſay divers things, that occurred not to me; yet I conſidered on the other ſide, that ſuch things would, notwithſtanding my ſilence, be found in the authors that delivered them; and it was very poſſible, that, by the courſe I took, I might light upon ſome thoughts, that I ſhould have miſſed, if I had prepoſſeſſed my mind with the opinions of others; which I was the leſs tempted to do, becauſe an eaſy proſpect of my theme ſufficed to let me ſee I was like to have the Epicureans and Carteſians for my adverſaries, not my aſſiſtants: and for the ſchool-philoſophers, the very ſlight account, that their maſter *Ariſtotle* gives of one of my four queſtions, (for of the reſt, as far as I remember, he ſays little or nothing,) gave me ſmall hopes of being aided by them; eſpecially ſince in this, as in many other queſtions, they proceed upon grounds, that I cannot aſſent to. Anatomiſts indeed, and ſome phyſicians, have done very laudably upon the uſes of the parts of the human body; which I take this occaſion to declare, that it may not be ſuſpected, that I do in the leaſt undervalue their happy induſtry, becauſe I tranſcribe not paſſages out of their books: the reaſons of which omiſſion are, not only, that I had not any one book of anatomy at hand, when I was writing, but, that the uſes of the parts of man's body related but to a ſmall part of my diſcourſe; to make which more comprehenſive, I took in the conſideration of more general queſtions, beſides that, which was controverted between *Ariſtotle* and the ancienter philoſophers, who diſputed how bodies, that were devoid of knowledge, could act for ends.

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* *Illud in his rebus vitium vehementer ineſto, Effugere illorumque errorem præmeditemus, Lumina qui faciunt oculorum clara creata proſpicere ut poſſimus* ——— *Lucr. de rer. nat. lib.* IV. *ſect.* 824.

† *Ita denique nullas unquam rationes circa res naturales, a fine, quem deus aut natura in iis faciendis ſibi propoſuit, deſumemus; qui non tantum nobis debemus arrogare ut ejus conſiliorum participes eſſe putemus: Carteſius princip. philoſop. parte prima artic.* 28.

THOSE, that reliſh no books in natural philoſophy but ſuch as abound in experiments, are ſeaſonably advertiſed, that I do not invite them to read this treatiſe; wherein I thought it much more ſuitable to the nature of my ſubject and deſign, to declare the works of God, than of men; and conſequently to deliver rather obſervations, than artificial experiments. And even of the former of theſe, though perhaps moſt readers may find in the enſuing diſcourſe ſeveral, that they have not met with in claſſic authors, yet I ſhall freely acknowledge, that, upon the review I made of what I writ, I find, though too late to repair the omiſſion, that I have left ſeveral things unmentioned, that would have been very pertinent to my ſubject; which may, I hope, be more eaſily excuſed, becauſe, the body of the following diſquiſition having been written many years ago, and thrown by upon the death of the * gentleman, that preſſed me for it, I could not then take notice of thoſe many diſcoveries in anatomy, and other parts of phyſiology, that have ſince been happily made. But perhaps ſome will think I may have more need to excuſe the largeneſs of ſome parts of the following treatiſe, compared with the others. And I ſhould rather grant than anſwer the objection, if I could not alledge, that the contagious boldneſs of ſome baptized Epicureans engaged me to dwell much longer on the third propoſition of the fourth ſection, than I at firſt intended. And on the other hand, the Carteſian opinion having of late made it requiſite to handle the formerly difficult queſtion, about the conſideration of final cauſes, after a new manner, I thought it unfit lightly to paſs over the paradox maintained by ſo great a man, and judged it expedient in ſome places (what I could not do without enlarging) to propoſe thoughts adjuſted to the preſent ſtate of things in this affair; in the management of which, I have had ſo much more regard to ſome other things, than to the ſymmetry of the parts, whereof this tract conſiſts, that I will not ſay, that I fear I have in it but thrown together materials for a juſt diſcourſe on my ſubject; ſince to do ſo was the main thing I intended. And if the materials be good and ſolid, they will eaſily, in ſo learned an age as this, find an architect, that will diſpoſe them in a more artful way, than I was either at leiſure or ſollicitous to do.

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* Mr. *Henry Oldenburg*, Secretary to the Royal Society.

AN
ESSAY,

INQUIRING

Whether, and how, a Naturalist ſhould conſider Final Causes.

To my very learned Friend Mr. *F. O.*

SIR,

THOUGH in a book or two of mine, that you have already been pleaſed to peruſe, there are ſome paſſages, whence you may eaſily enough gather, what I thought about your queſtions; yet becauſe the ſubject is of great moment, as well as difficulty, and you may ſuſpect I have altered my opinion, I ſhall, without referring you to writings, which perhaps neither you nor I have at hand, ſet down ſuccinctly, but yet as if I had ſaid nothing of any of them before, my preſent thoughts about theſe four queſtions.

I. Whether, generally or indefinitely ſpeaking, there be any final cauſes of things corporeal, knowable by naturaliſts?

II. Whether, if the firſt queſtion be reſolved in the affirmative, we may conſider final cauſes in all ſorts of bodies, or only in ſome peculiarly qualified ones?

III. Whether, or in what ſenſe, the acting for ends may be aſcribed to an unintelligent, and even inanimate body?

IV. And laſtly, how far, and with what cautions, arguments may be framed upon the ſuppoſition of final cauſes?

SECT. I.

TO begin with the firſt queſtion; thoſe, that would exclude final cauſes from the conſideration of the naturaliſt, are wont to do it (for aught I have obſerved) upon one of theſe two accounts: either that, with *Epicurus*, they think the world was the production of atoms and chance, without any intervention of a deity; and that conſequently it is improper and in vain to ſeek for final cauſes in the effects of chance: or, that they judge, with *Des Cartes*, that God being an omniſcient agent, it is raſh and preſumptuous for men to think, that they know, or can inveſtigate, what ends he propoſed to himſelf in his actings about his creatures. The ground, on which the Epicureans have rejected final cauſes, has been diſallowed by the philoſophers of almoſt all other ſects; and ſome have written ſufficient confutations of it, which therefore I ſhall here forbear to inſiſt on; though ſome things I ſhall upon occaſion obſerve, that may help, if not ſuffice, to diſcredit ſo unreaſonable an opinion. But the Carteſian argument has been ſo prevalent among many learned and ingenious men, that it will be worth while (if it be but to excite better pens) to ſpend ſome time in the conſideration of it.

Perhaps one thing, that alienated that excellent philoſopher, from allowing the conſideration of final cauſes in phyſics, was, that the ſchool-philoſophers, and many other learned men, are wont to propoſe it too unwarily, as if there were no creature in the world, that was not ſolely, or at leaſt chiefly, deſigned for the ſervice or benefit of man; inſomuch, that I remember I have ſeen a body of divinity, publiſhed by a famous writer, wherein, to prove the opinion he favours, of thoſe, that would have the world annihilated after the day of judgment, he urgeth this argument; that ſince the world was made for the ſake of man in his travelling condition (*hominis viatoris cauſa*,) when once man is poſſeſſed of his everlaſting ſtate of happineſs or miſery, there will be no further uſe of the world. The opinion, that gives riſe to ſuch preſumptuous and unwarrantable expreſſions, did, as I gueſs by his objection, more ſhock *Des Cartes*, than I wonder, that it ſhould diſpleaſe him. But the indiſcretion of men ought not to prejudice truth; which muſt not be caſt away, with the unwarrantable conceits, that ſome men have pinn'd upon it.

Wherefore, ſince I cannot entirely cloſe, either with the opinion of the Epicureans, or of the Carteſians, I ſhall leave each party to maintain its own opinion, and proceed to propoſe mine; for the clearing of which, and indeed of the diſquiſition of final cauſes, I ſhall beg leave to premiſe a diſtinction, which, though novel, I ſhall venture to employ, becauſe it comprizes and diſtinguiſhes ſome things, which I think ought neither to be overlooked nor confounded.

I CONCEIVE then, that when we ſpeak of the ends, which nature, or rather the author of nature, is ſaid to have in things corporeal, one of theſe four things may be ſignified, or, if you like that expreſſion better, the end deſigned by nature may be fourfold:

FIRST, there may be ſome grand and general ends of the whole world, ſuch as the exerciſing and diſplaying the creator's immenſe power and admirable wiſdom, the communication of his goodneſs, and the admiration and thanks due to him from his intelligent creatures, for theſe his divine excellencies, whoſe productions manifeſt his glory. And theſe ends, becauſe they regard the creation of the whole univerſe, I call the univerſal ends of God or nature.

SECONDLY, in a ſomewhat more reſtrained ſenſe, there may be ends deſigned in the number, fabric, placing, and ways of moving the great maſſes of matter, that, for their bulks or qualities, are conſiderable parts of the world; ſince it is very probable, that theſe bodies, ſuch as the ſun, moon, and fixed ſtars, and the terraqueous globe, and perhaps each of its two chief parts, the earth and the ſea, were ſo framed and placed, as not only to be capable of perſevering in their own preſent ſtate, but alſo as was moſt conducive to the univerſal ends of the creation, and the good of the whole world, whereof they are notable parts. Upon which account theſe ends may, for diſtinction's ſake, be called coſmical or ſyſtematical, as regarding the ſymmetry of the great ſyſtem of the world.

THERE is a third ſort of ends, that do more peculiarly concern the parts of animals, (and probably plants too) which are thoſe, that the particular parts of animals are deſtinated to, and for the welfare of the whole animal himſelf, as he is an entire and diſtinct ſyſtem of organized parts, deſtinated to preſerve himſelf and propagate his ſpecies, upon ſuch a theatre, (as the land, water, or air) as his ſtructure and circumſtances determine him to act his part on. And theſe ends, to diſcriminate them from others, may be called animal ends.

FOURTHLY, and laſtly, there is another ſort of ends, which, becauſe they relate particularly to man, may, for brevity's ſake, be called human ends; which are thoſe, that are aimed at by nature, where ſhe is ſaid to frame animals and vegetables, and other of her productions, for the uſe of man. And theſe ends themſelves may be diſtinguiſhed into mental, that relate to his mind, and corporeal, that relate to his body, not only as he is an animal framed like other animals, for his own preſervation, and the propagation of his ſpecies (mankind;) but alſo as he is framed for dominion over other animals and works of nature, and fitted to make them ſubſervient to the deſtinations, that one may ſuppoſe to have been made of them to his ſervice and benefit.

THIS diſtinction of final cauſes, which, I hope, will not prove altogether uſeleſs, being premiſed, I ſhall begin my intended diſcourſe, by owning a diſſent from both the oppoſite opinions; theirs, that, with the vulgar of learned men, will take no notice of final cauſes but thoſe we have ſtiled human ones; and theirs, that (as they think with *Des Cartes*) reject final cauſes altogether; ſince, though I judge it erroneous to ſay in the ſtricteſt ſenſe, that every thing in the viſible world was made for the uſe of man, yet I think it is more erroneous to deny, that any thing was made for ends inveſtigable by man.

IT is a known principle of the Carteſian philoſophy, that there is always juſt the ſame quantity of motion in the world at one time, that there is at another: of which aſſertion this reaſon is given, that there is no cauſe, why God, who is immutable, ſhould at the beginning of things, when he firſt put matter into motion, have given it ſuch a quantity of motion, as would need to be afterwards augmented or leſſened. But I ſee not, how by this negative way of arguing, thoſe, that employ it, do not (implicitly at leaſt) take upon them to judge of the ends, that God may have propoſed to himſelf in natural things. For, without a ſuppoſition, that they know what God deſigned in ſetting matter a-moving, it is hard for them to ſhew, that his deſign could not be ſuch, as might be beſt accompliſhed by ſometimes adding to, and ſometimes taking from, the quantity of motion he communicated to matter at firſt. And I think it may be worth conſidering, whether, by this doctrine of theirs, the Carteſians do not more take upon them, than other philoſophers, to judge of God's deſigns. For, if a man be known to be very wiſe, and have various ways of compaſſing his ſeveral ends, he, that, ſeeing ſome of thoſe ways have a direct tendency to ſome rational end, ſhall conclude that end to be one of thoſe, that is intended, does thereby leſs preſume, and expreſs more reſpect to that wiſe man, than he, that ſhould conclude, that thoſe cannot be his ends, and that he can have no other deſign knowable by us, except a certain general one named by the aſſertor. And indeed, it ſeems more eaſy to know, that this or that particular thing, for which an engine is proper, may be, among others, intended by the artificer, though never ſo ſkilful, than to know negatively, that he can have no other, than ſuch or ſuch an end.

AND how will a Carteſian aſſure me, that among the many ends, that he grants that God may have propoſed to himſelf in the production of his mundane creatures, one may not be, that we, whom he has vouchſafed to make intelligent beings, and capable of admiring and praiſing him, ſhould find juſt cauſe to do ſo, for the wiſdom and goodneſs he has diſplayed in the world? which attributes we could not well diſcern or celebrate, unleſs we knew as well, that the creatures were made for ſuch uſes, as that they are exceedingly well fitted for them. I know God's immutability is alledged, to prove, that the quantity of motion is never varied; but to me it is not evident, why God's having particular ends, though ſome of them ſeem to require a change in his way of acting in natural things, muſt be more inconſiſtent with his immutability, than his cauſing many things to be brought to paſs, which though *ab æterno* he decreed to do, are yet not actually done, unleſs in proceſs of time. And particularly it ſeems not clear, why God may not as well be immutable, though he ſhould ſometimes vary the quantity of motion, that he has put into the world, as he is, though, according to the opinion of moſt of the Carteſians themſelves, he does daily create multitudes of rational ſouls, to unite them to human bodies; eſpecially conſidering, that theſe newly created ſubſtances are, according to *Des Cartes*, endowed with a power, to determine and regulate the motions of the ſpirits and the conarion, which are things clearly corporeal. I ſay not this, as if I abſolutely rejected the Carteſian doctrine, about the continuance of the ſame quantity of motion in the whole maſs of matter; for, whether or no it be a truth, I think it no unuſeful nor improbable hypotheſis; and I have not ſo much argued againſt it, as upon the grounds, on which they argue for it.

Wherefore, to come now to the thing itſelf, whereas monſieur *Des Cartes* objects, that it is a preſumption for man to pretend to be able to inveſtigate the ends, that the omniſcient God propoſed to himſelf in the making of his creatures; I conſider, by way of anſwer, that there are two very differing ways, wherein a man may pretend to know the ends of God in his viſible works: for, he may either pretend to know only ſome of God's ends, in ſome of his works; or he may pretend to know all his ends. He, that arrogates to himſelf to diſcover God's ends in this latter ſenſe, will ſcarce be excuſed from a high preſumption, and no leſs a folly, from the reaſon lately intimated in the Carteſian objection. But to pretend to know God's ends in the former ſenſe, is not a preſumption, but rather to take notice of them is a duty. For there are ſome things in nature ſo curiouſly contrived, and ſo exquiſitely fitted for certain operations and uſes, that it ſeems little leſs than blindneſs in him, that acknowledges, with the Carteſians, a moſt wiſe author of things, not to conclude, that, though they may have been deſigned for other, and perhaps higher uſes, yet they were deſigned for this uſe. As he, that ſees the admirable fabric of the coats, humors, and muſcles of the eye, and how excellently all the parts are adapted to the making up of an organ of viſion, can ſcarce forbear to believe, that the author of nature intended it ſhould ſerve the animal, to which it belongs, to ſee with. The Epicureans indeed, that believe the world to have been produced but by the caſual concourſe of atoms, without the intervention of any intelligent being, may have a kind of excuſe, whereof other philoſophers are deſtitute, that acknowledge a Deity, if not alſo a Providence. For the very ſuppoſition, for inſtance, that a man's eyes were made by chance, argues, that they need have no relation to a deſigning agent; and the uſe, that a man makes of them, may be either caſual too, or at leaſt may be an effect of his knowledge, not of nature's. But when, upon the anatomical diſſection, and the optical conſideration, of a human eye, we ſee it is as exquiſitely fitted to be an organ of ſight, as the beſt artificer in the world could have framed a little engine, purpoſely and mainly deſigned for the uſe of ſeeing; it is very harſh and incongruous to ſay, that an artificer, who is too intelligent either to do things by chance, or to make a curious piece of workmanſhip, without knowing what uſes it is fit for, ſhould not deſign it for an uſe, to which it is moſt fit.

It is not to be denied, that he may have more uſes for it than one, and perhaps ſuch uſes, as we cannot divine: but this hinders not, but that, among its ſeveral uſes, this, to which we ſee it ſo admirably adapted, ſhould be thought one. And I ſee not, how it does magnify God's wiſdom, or expreſs our veneration of it, to exclude out of the number of his ends in framing human eyes, that moſt obvious and ready uſe, which we are ſure is made of them, and which they could not be better fitted for. This may perhaps be not unfitly illuſtrated by the following compariſon, whereof the application were ſuperfluous. Suppoſe, that a country man, being in a clear day brought into the garden of ſome famous mathematician, ſhould ſee there one of thoſe curious gnomonic inſtruments, that ſhew at once the place of the ſun in the zodiack, his declination from the æquator, the day of the month, the length of the day, *&c.* It would indeed be preſumption in him, being unacquainted both with the mathematical diſciplines, and the ſeveral intentions of the artiſt, to pretend or think himſelf able to diſcover all the ends, for which ſo curious and elaborate a piece was framed: but when he ſees it furniſhed with a ſtyle, with horary lines and numbers, and in ſhort, with all the requiſites of a ſun dial, and manifeſtly perceives the ſhadow to mark from time to time, the hour of the day, it would be no more a preſumption than an error in him to conclude, that (whatever other uſes the inſtrument is fit, or was deſigned for) it is a ſun-dial, that was meant to ſhew the hour of the day.

And here I ſhall demand of thoſe, that will not allow us to think, that any natural things are directed to ends knowable by men; whether, if the divine Author of them had really deſigned them for ſuch ends, the things themſelves are not ſo framed and directed, as in that caſe they ſhould be? And whether the fabrick and management of natural things do really countenance or contradict our ſuppoſition?

FOR my part, after what has been already diſcourſed, I ſcruple not to confeſs, that I ſee not, why it ſhould be reputed a diſparagement to the wiſdom of any agent whatſoever, to think, that his productions were deſigned for ſuch ends, among others, as they are excellently framed and fitted for; unleſs it did appear, that thoſe ends were unworthy to be deſigned by the wiſe Agent. But that cannot be juſtly ſaid in our preſent caſe; ſince it is not injurious to the divine Author of things, to believe that ſome of the ends, to which he deſtinated divers of his corporeal works, were, to exert and communicate his exuberant goodneſs, and to receive from his intelligent creatures, ſuch as men, an ardent love, a high admiration, and an obſequious gratitude, for having diſplayed ſo much wiſdom and beneficence, in exquiſitely qualifying his works to be wonderfully ſerviceable to one another, and a great number of them to be particularly ſubſervient to the neceſſities and utilities of man.

AND indeed I can by no means aſſent to that aſſertion of *M. Des Cartes*, * That it cannot be ſaid, that ſome of God's ends (in his corporeal works) are more manifeſt than others; but that all of them lie equally hid in the abyſs of the divine Wiſdom; ſince there are many of his creatures, ſome of whoſe uſes are ſo manifeſt and obvious, that the generality of mankind, both philoſophers and plebeians, have in all ages, and almoſt in all countries, taken notice of, and acknowledged them. And as to what he adds, (by which he ſeems to intimate the motive, that led him to make the forementioned aſſertion) that in phyſics, all things ought to be made out by certain and ſolid reaſons; to this I anſwer, firſt, that I ſee not, why the admitting, that the Author of things deſigned ſome of his works for theſe or thoſe uſes, amongſt others, may not conſiſt with the phyſical accounts of making of thoſe things; as a man may give a mechanical reaſon of the ſtructure of every wheel and other part of a watch, and of their way of acting upon one another, when they are rightly put together, and in ſhort, of the contrivance and phænomena of the little machine; though he ſuppoſe, that the artificer deſigned it to ſhew the hours of the day, and though he have that intended uſe in his eye, whilſt he explicates the fabric and operations of the watch. I anſwer, ſecondly, that I readily admit, that in phyſics we ſhould indeed ground all things upon as ſolid reaſons, as may be had; but I ſee no neceſſity, that thoſe reaſons ſhould be always preciſely phyſical; eſpecially if we be treating, not of any particular phænomenon, that is produced according to the courſe of nature eſtabliſhed in the world, already conſtituted as this of ours is; but of the firſt and general cauſes of the world itſelf; from which cauſes, I ſee not, why the final cauſes, or uſes, that appear manifeſtly enough to have been deſigned, ſhould be excluded. And to me it is not very material, whether or no, in phyſics, or any other diſcipline, a thing be proved by the peculiar principles of that ſcience or diſcipline, provided it be firmly proved by the common grounds of reaſon. And on this occaſion let me obſerve, that the fundamental tenets of M. *Des Cartes*'s own philoſophy are not by himſelf proved by arguments ſtrictly phyſical, but either by metaphyſical ones, or the more catholic dictates of reaſon, or the particular teſtimonies of experience. For when, for inſtance, he truly aſcribes to God all the motion, that is found in matter, and conſequently all the variety of phænomena, that occur in the world; he proves not, by an argument preciſely phyſical, that God, who is an immaterial agent, is the efficient cauſe of motion in matter; but only by this, that ſince motion does not belong to the eſſence and nature of matter, matter muſt owe the motion it has to ſome other being: and then it is moſt agreeable to common reaſon to infer, that ſince matter cannot move itſelf, but it muſt be moved by ſome other being, that being muſt be immaterial, ſince otherwiſe ſome matter muſt be able to move itſelf contrary to the hypotheſis. And when *Des Cartes* goes to demonſtrate, that there is always in the univerſe the ſelf-ſame quantity of motion, (that is, juſt as much at any one time, as at any other) and conſequently, that as much motion as one body communicates to another, it loſes itſelf; he proves it by the immutabily of God, which is not a phyſical argument ſtrictly ſo called, but rather a metaphyſical one; as he formerly proved God's being the cauſe of all motion in matter, not by principles peculiar to phyſics, but by the common grounds of reaſon.

† THOUGH *Monſieur Des Cartes* does, as I have formerly ſhewn, ſpeak very dogmatically and univerſally, againſt men's endeavouring or pretending to know any final cauſes in natural things; for which reaſon I have, as well as the generality of his other readers, and even his diſciples, looked upon the ſenſe of thoſe poſitive expreſſions, as containing his opinion; yet, ſince I writ the foregoing part of this treatiſe, I lighted on a paſſage of his, wherein he ſeems to ſpeak more cautiouſly or reſervedly, oppoſing his reaſoning to their opinion, who teach, that God hath no other

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* *Nec fingi poteſt, aliquos Dei fines, magis quam alios, in propatulo eſſe; omnes enim in imperſcrutabili ejus ſapientiæ abyſſo ſunt eodem modo reconditi.* Reſp. *Quart. ad object. Gaſſendi.*

† *C'eſt une choſe, qui de ſoy eſt manifeſte, que nous ne pouvons connoiſtre les fins de Dieu, ſi luy meſme ne nous les revele. Et encore qu'il ſoit vray en morale, eu egard a nous autres hommes, que toutes choſes ont eſte faites pour la gloire de Dieu, a cauſe que les hommes ſont obligez de louer Dieu pour tous ſes ouvrages; & qu'on puiſſe auſſi dire, que le ſoleil a eſte fait pour nous eclairer, pour ce que nous experimentons, que le ſoleil en effet nous eclaire: ce ſeroit toutesfois une choſe puerile & abſurde, d'aſſurer en metaphyſique, que Dieu, a la facon d'un homme ſuperbe, n'auroit point eu d'autre fin en baſtiſſant le monde, que celle d'eſtre loue par les hommes; et qu'il n'auroit cree le ſoleil, qui eſt pluſieurs fois plus grand que la terre, a autre deſſein, que d'eclairer l'homme, qui n'en occupe qu'une tres petite partie.*

end in making the world, but that of being praiſed by men. But in that ſhort diſcourſe, whereof this paſſage is a part, there are two or three other things, wherein I cannot acquieſce. As firſt, that it is ſelf-evident, that we cannot know the ends of God, unleſs he himſelf reveal them to us; (he muſt mean in a ſupernatural way, if he will not ſpeak impertinently:) for what he ſays to be evident of itſelf, is not at all ſo to the generality of mankind, and even of philoſophers; and therefore, I think, it ought not to be barely pronounced, but (if it can be) ſhould be proved. And next, he does not ſhew, how we are obliged to praiſe God for his works, if he had no intention to have us do ſo, or that we ſhould diſcover any of the ends, for which he made them. If a judicious man ſhould ſee a great book, written in ſome Indian language, which he is utterly a ſtranger to, and ſhould know nothing of it, but that it was made by a very intelligent phyſician; he might indeed conclude, that the work was not made by chance, but would have no means to be convinced by the inſpection of the book itſelf, that it was compoſed with great ſkill and kindneſs, and deſerved his praiſe and thanks; ſince he could not know any of the particular ends, to which the ſeveral chapters of it were deſtinated, nor conſequently diſcover how ſkilfully they were fitted to reach ſuch ends. What *Des Cartes* ſays, that it is childiſh and abſurd to think, that God had created the ſun, which is many times bigger than the earth, only to afford light to man, who is but a ſmall part of it, is ſomewhat invidiouſly propoſed; there being few able writers, that confine the utility of the ſun directly to the affording light to man; and the littleneſs of his bulk ought not to make it thought abſurd, that God may have had an eſpecial eye to his welfare, in framing that bright globe; ſince not only, for aught appears to us, that moſt excellent engine of man's body is a more admirable thing than the ſun, but the rational and immortal ſoul, that reſides in it, is incomparably more noble than a thouſand maſſes of brute matter, and that not ſo much as organized, can be juſtly reputed, (as will be hereafter more fully declared.) And ſince, in this very diſcourſe, the acute author of it confeſſes, that we may know the ends of God's corporeal works, if he reveal them to us; a Chriſtian philoſopher may be allowed to think the ſun was made, among other purpoſes, to enlighten the earth, and for the uſe of man, ſince the ſcripture teaches us, that not only the ſun and moon, but the ſtars of the firmament, which *Des Cartes* not improbably thinks to be ſo many ſuns, were made to give light to the earth, and were divided to all the nations that inhabit it. Perhaps it were not raſh to add, that I ſee not, why the belief, that a man may know ſome of God's ends in things corporeal, ſhould more derogate from our veneration of his wiſdom, than to think we know ſome of his ends in other matters, of which the ſcripture furniſhes us with a multitude of inſtances, as (particularly) that of *Job* ſacrificing for his friends; and the declared uſes of the Urim and Thummim: ſince God may, if he pleaſes, declare truths to men, and inſtruct them, by his creatures and his actions, as well as by his words: as when he taught *Noah* by the rain-bow, and *Jonah* by a gourd and a worm, and regulated the incampment of the Iſraelites by the guidance of a cloud and a fiery pillar. Laſtly, whereas *Monſieur des Cartes* objects, that thoſe he diſſents from, talk, as if they looked upon God as a proud man, who deſigned his works only to be praiſed for them; I know not, whether in this place he ſpeaks ſo cautiouſly and reverently of God, as he ought, and elſewhere is wont to do. For as humility, though it be a virtue in men, is extremely remote from being any of God's perfections; ſo that may be pride in a man, who is but a creature, imperfect, dependent, and hath nothing, that he has not received, which would be none at all in God, who is uncapable of vice, and who may, if he pleaſe, juſtly propoſe to himſelf his own glory for one of his ends, and both require and delight to be praiſed by men for his works; ſince he is moſt worthy of all praiſe, and it is their duty and reaſonable ſervice, which he is graciouſly pleaſed to approve of, to pay it him.

Dent. iv. 19.

IT is not without trouble, that I find my ſelf obliged, by the exigency of my deſign, ſo much to oppoſe, in ſeveral places of this preſent diſcourſe, ſome ſentiments of *M. Des Cartes*, for whom otherwiſe I have a great eſteem, and from whom I am not forward to diſſent: and this I the rather declare to you, becauſe I am not at all of their mind, that think *M. Des Cartes* a favourer of atheiſm, which, to my apprehenſion, would ſubvert the very foundation of thoſe tenets of mechanical philoſophy, that are particularly his. But judging, that his doctrine (at leaſt as it is underſtood by ſeveral of his followers, as well as his adverſaries,) about the rejection of final cauſes from the conſideration of naturaliſts, tends much to weaken, (as is elſewhere noted) if not quite to deprive us of one of the beſt and moſt ſucceſsful arguments to convince men, that there is a God, and that they ought to admire, praiſe, and thank him; I think it my duty to prefer an important truth before my reſpect to any man, how eminent ſoever, that oppoſes it, and to conſider more the glory of the great Author of nature, than the reputation of any one of her interpreters.

AND to ſtrengthen what I have been ſaying, give me leave to mind you more expreſly here of what I have elſewhere intimated, *viz.* that the excellent contrivance of the great ſyſtem of the world, and eſpecially the curious fabric of the bodies of animals, and the uſes of their ſenſories, and other parts, have been made the great motives, that in all ages and nations induced philoſophers to acknowledge a Deity, as the author of theſe admirable ſtructures; and that the nobleſt and moſt intelligent praiſes, that have been paid him by the prieſts of nature, have been occaſioned and indited by the tranſcending admiration, which the attentive contemplation of the fabric of the univerſe, and of the curious ſtructures of living creatures, juſtly produced in them. And therefore it ſeems injurious to God, as well as unwarrantable in itſelf, to baniſh from natural philoſophy the conſideration of final cauſes; from which chiefly, if not only, I cannot but think (though ſome learned men do otherwiſe) that God muſt reap the honour, that is due to thoſe glorious attributes, his wiſdom, and his goodneſs. And I confeſs I ſometimes wonder, that the Carteſians, who have generally, and ſome of them ſkilfully, maintained the exiſtence of a Deity, ſhould endeavour to make men throw away an argument, which the experience of all ages ſhews to have been the moſt ſucceſsful, (and in ſome caſes the only prevalent one) to eſtabliſh, among philoſophers, the belief and veneration of God. I know the *Carteſians* ſay, that their maſter has demonſtrated the exiſtence of a God, by the innate idea, that men have of a being infinitely perfect, who left it upon the mind of man, as the mark of an artiſt impreſt upon his work; and alſo, that they aſcribe to God the having made matter out of nothing, and alone put it into motion; which ſufficiently argue the immenſity of his power. But though I would by no means weaken the argument drawn from the inbred notion of God, ſince I know, that divers learned men have acquieſced in it; yet, on the other ſide, I ſee not, why we may not reaſonably think, that God, who, as themſelves confeſs, has been pleaſed to take care men ſhould acknowledge him, may alſo have provided for the ſecuring of a truth of ſo great conſequence, by ſtamping characters, or leaving impreſſes, that men may know his wiſdom and goodneſs by, as well without, upon the world, as within, upon the mind. The bare ſpeculation of the fabrick of the world, without conſidering any part of it, as deſtinated to certain (or determinate) uſes, may ſtill leave men unconvinced, that there is any intelligent, wiſe, and provident author and diſpoſer of things; ſince we ſee generally the *Ariſtotelians* (before ſome of them were better inſtructed by the Chriſtian religion) did, notwithſtanding the extent, ſymmetry, and beauty of the world, believe it to have been eternal. And though they, whatever their maſter thought, did not believe it to have been created by God; yet, becauſe they aſſerted, that animals, plants, *&c.* act for ends, they were obliged to acknowledge a provident and powerful being, that maintained and governed the univerſe, which they called nature; though they too often dangerouſly miſtook, by ſometimes confounding this being with God himſelf, and at other times ſpeaking of it as co-ordinate with him, as in that famous axiom of *Ariſtotle*, *Deus & natura nihil faciunt fruſtra.* I acknowledge therefore, that, as I ſet a juſt value upon the *Carteſian* proof of God's exiſtence, ſo I ſee no reaſon, why we ſhould diſfurniſh ourſelves of any other ſtrong argument to prove ſo noble and important a truth; eſpecially, ſince the *Carteſian* way of conſidering the world is very proper indeed to ſhew the greatneſs of God's power, but not, like the way I plead for, to manifeſt that of his wiſdom and beneficence. For, whereas a *Carteſian* does but ſhew, that God is admirably wiſe, upon the ſuppoſition of his exiſtence; in our way the ſame thing is manifeſted by the effect of a wiſdom, as well as power, that cannot reaſonably be aſcribed to any other, than a moſt intelligent and potenr being: ſo that by this way men may be brought, upon the ſame account, both to acknowledge God, to admire him, and to thank him.

SECT. II.

TO give you now my thoughts of the ſecond queſtion, *viz. Whether we may conſider final cauſes in all ſorts of bodies, or only in ſome peculiarly qualified ones*; I muſt divide natural bodies into animate and inanimate. The former of which terms I here take in the larger ſenſe of thoſe, who under it comprehend, not only animals, but vegetables; though I ſhall not diſdainfully reject the opinion of thoſe learned men, that are unwilling to allow plants a ſoul or life, at leaſt as properly ſo called, as that, which is confeſſedly granted to animals.

OF the inanimate bodies of the univerſe, the nobleſt, and thoſe, which, on this occaſion, deſerve chiefly to be conſidered, are the ſun, planets, and other cœleſtial bodies. For, when men ſaw thoſe vaſt and luminous globes, and eſpecially the ſun, move ſo conſtantly, and ſo regularly, about the earth, and diffuſe on it light and heat; and by their various revolutions produce day and night, ſummer and winter, and the viciſſitudes of ſeaſons, that are ſo opportune for the inhabitants of the earth: the obſervers, I ſay, of all this concluded, both that theſe motions were guided by ſome divine being, and that they were deſigned for the benefit of man. Whether this be a demonſtrative collection, I ſhall not now debate; but I ſee not, why it may not have thus much of probability in it, that in caſe a man ſhall think, that the fabrick of the cœleſtial parts of the world, was the curious production of an intelligent and divine agent, the regular phænomena of the heavens will not contradict him; ſince there is nothing in that fabrick, that miſbecomes a divine author; and the motions and operations of the ſun and ſtars are not ſuch, but that they will allow us to think, that, among other purpoſes, they were made to illuminate the terreſtrial globe, and bring heat and other benefits to the inhabitants of it: ſo that the contemplation of the heavens, which ſo manifeſtly *declare the glory of God*, may juſtly excite men, both to admire his Pſal. xix. 1.

power and wiſdom in them, and to return him thanks and praiſes for the great benefits, that accrue to us by them.

But now, on the other ſide, it may be ſaid, that in bodies inanimate, whether the portions of matter they conſiſt of be greater or leſſer, the contrivance is very rarely ſo exquiſite, but that the various motions and occurſions of the parts of matter may be, without much improbability, ſuſpected to be capable, after many eſſays, to caſt one another into divers of thoſe circumvolutions of matter, that, I remember, *Epicurus* calls συστροφὰς and *Des-Cartes vortices*; which being once made, may continue very long, by the means expreſſed by *Carteſius*, or by ſome other as probable ones. But, without allowing this hypotheſis to be more than not very improbable, when I conſider, what cauſes there may be to fear, that we are not yet ſufficiently acquainted with the true ſyſtem of the world, and are not uſually ſenſible enough, how ſmall a part we, and the terreſtrial globe we inhabit, make of the univerſe; I am apt to fear too, that men are wont, with greater confidence than evidence, to aſſign the ſyſtematical ends and uſes of the cœleſtial bodies, and to conclude them to be made and moved only for the ſervice of the earth and its inhabitants. And though, even as a meer naturaliſt, I will not deny, that, as man actually receives benefits by the eſtabliſhed order and motion of the ſtars, ſo one of the ſeveral uſes intended by the author of nature in them, may particularly reſpect men; yet I am apt to think, that, by what we hitherto know, it will not be eaſy to be proved, that ſome, at leaſt, of the cœleſtial bodies and motions may not be intended more for other purpoſes, than to caſt their beams, or ſhed their influences (ſuppoſing they have ſome) upon the earth. And, at leaſt, I cannot but think, that the ſituations of the cœleſtial bodies, do not afford by far ſo clear and cogent arguments of the wiſdom and deſign of the author of the world, as do the bodies of animals and plants. And, for my part, I am apt to think, there is more of admirable contrivance in a man's muſcles, than in (what we yet know of) the cœleſtial orbs; and that the eye of a fly is, (at leaſt as far as appears to us,) a more curious piece of workmanſhip, than the body of the ſun.

As for other inanimate bodies, as ſtones, metals &c, whoſe matter ſeems not organized, though there be no abſurdity to think, that they alſo were made for diſtinct particular purpoſes, if not alſo for human uſes; yet moſt of them are of ſuch eaſy and unelaborate contextures, that it ſeems not abſurd to think, that various occurſions and juſtlings of the parts of the univerſal matter may at one time or other have produced them; ſince we ſee in ſome chymical ſublimations, and chriſtallizations of mineral and metalline ſolutions, and ſome other phænomena, where the motions appear not to be particularly guided and directed by an intelligent cauſe, that bodies of as various contextures, as thoſe are wont to be, may be produced; of which I have elſewhere given ſome inſtances.

If it be objected, that if we allow chance, or any thing elſe, without the particular guidance of a wiſe and all-diſpoſing cauſe, to make a finely ſhaped ſtone, or a metalline ſubſtance, growing, as I have ſometimes ſeen ſilver to do, in the form of a plant, it ought not to be denied, that chance may alſo make vegetables and animals; I can by no means allow the conſequence. There are ſome effects, that are ſo eaſy, and ſo ready to be produced, that they do not infer any knowledge or intention in their cauſes; but there are others, that require ſuch a number and concourſe of conſpiring cauſes, and ſuch a continued ſeries of motions or operations, that it is utterly improbable they ſhould be produced without the ſuperintendency of a rational agent, wiſe and powerful enough to range and diſpoſe the ſeveral intervening agent's and inſtruments, after the manner requiſite to the production of ſuch a remote effect. And therefore it will not follow, that if chance could produce a ſlight contexture in a few parts of matter, we may ſafely conclude it able to produce ſo exquiſit and admirable a contrivance, as that of the body of an animal. What then, if ſometimes in ſawing pieces of variegated marble, men happen, though rarely, to meet with the delineations or pictures (ſome of which I have beheld with pleaſure) of towns, woods, and men? for, beſides that the pleaſingneſs and rarity of ſuch ſpectacles inclines the imagination to favour them, and ſupply their defects; would any wiſe man therefore conclude, that a real town or wood, much leſs numbers of men, ſhould be made by ſuch a fortuitous concourſe of matter? What compariſon is there betwixt the workmanſhip, that ſeems to be expreſſed in a few irregular lines drawn upon a plane ſuperficies, and perhaps two or three colours luckily placed, and the great multitude of nerves, veins, arteries, ligaments, tendons, membranes, bones, glandules, &c. that are required to the compleating of a human body; of which numerous parts (for the bones alone are reckoned to amount to three hundred) every one muſt have its determinate ſize, figure, conſiſtence, ſituation, connexion, &c. and many, or all of them together, muſt conſpire to ſuch and ſuch determinate functions or uſes? And indeed, though I keep by me ſome curious ones, yet I never ſaw any inanimate production of nature, or, as they ſpeak, of chance, whoſe contrivance was comparable to that of the meaneſt limb of the deſpicableſt animal: and there is incomparably more art expreſſed in the ſtructure of a dog's foot, then in that of the famous clock at Straſburg.

And though the paw of a dog will be confeſſed to be of a ſtructure far inferior to that of the hand of a man; yet even this, however *Ariſtotle* prettily ſtyles it the inſtrument of inſtruments, is a leſs conſiderable inſtance to my preſent purpoſe, than another inſtance, which therefore, ſince my intended brevity permits me not to conſider many, I ſhall pitch upon, as that, which I ſhall almoſt only inſiſt on in the following part of this tract: and this inſtance is afforded me by the eye. For though the parts, that concur to make up that admirable organ of viſion, are very numerous, yet how little any of them could have been ſpared or altered, unleſs for the worſe, may appear by that great number of diſeaſes, that have been obſerved in that little part of the body: ſince each of thoſe diſeaſes conſiſt in this, that ſome of the coats, humours, or other parts of the eye, are brought into a ſtate differing from that, whereto nature had deſigned it, and whereinto ſhe had put it. It would be tedious ſo much as to enumerate the ſeveral diſtempers of the eye, whereunto phyſicians have given particular names; wherefore I ſhall only mention two or three things, wherein one would ſcarce imagine, that a ſmall receſs from the natural ſtate could bring any conſiderable, or perhaps ſenſible, inconvenience. That, which we call the pupil, is not (you know) a ſubſtantial part of the eye, but only a hole of the uvea; which aperture is almoſt perpetually changing its bigneſs, according to the differing degrees of light, that the eye chances from time to time to be expoſed to: and therefore one would not think, but that, whilſt this hole remains open, it performs well enough its part, which is, to give admiſſion to the incident beams of light, whether direct or reflected. And yet I lately ſaw and diſcourſed with a woman, who, after a fever, was not able to dilate the pupils of her eyes as formerly; and though they were ſo very little narrower than ordinary, that I ſhould ſcarce have taken any notice that it was at all ſo, if ſhe had not told me of it, yet ſhe complained ſhe had thereby almoſt loſt her ſight, ſeeing objects in certain lights but very dimly and imperfectly. And though the præternatural conſtriction of the pupil be not a frequent diſtemper, yet it is not ſo rare, but that phyſicians have given it a place among the ſtated diſeaſes of the eye. And on the other ſide though it appear by what hath been newly related, that a competent wideneſs of the pupil is requiſite to clear and diſtinct viſion, yet if its wideneſs exceed due limits, there is produced that diſtemper called *dilatatio pupillæ*; which is worſe than the former, becauſe it oftentimes deprives the patient almoſt totally of his ſight. And though it may ſeem but a ſlight circumſtance, that the tranſparent coats of the eye ſhould be devoid of colour, and of as little moment, that the *cornea* ſhould be very ſmooth, provided it be tranſparent; yet, when either of theſe circumſtances is wanting, the ſight may be much vitiated: as we ſee, that in the yellow-jaundice, when it is come to a high degree, the adventitious tincture, wherewith the eye is imbued, makes men think they ſee a yellowneſs in many objects, to which that colour does not belong. And I know an ingenious gentleman, who having had a ſmall *puſtula* excited and broken upon the *cornea*, though the eye have been long whole; yet a very little inequality or depreſſion, that ſtill remains upon the ſurface of the tranſparent *cornea*, does ſo affect him, that though he can read well in a room, yet when he comes into the open fields or the ſtreets, he for a pretty while (as himſelf has particularly complained to me) thinks many of the objects he looks on very glaring, and ſees many others, as men do ſtones at the bottom of a brook or running water; which I impute to the want of uniformity in the refraction of thoſe reflected beams of light, that fall upon the *cornea*, whoſe ſurface is not ſo ſmooth and equal as it ſhould be.

To give ſome further proof, that the eye was made with deſign, I ſhall here take notice of an obſervation or two, that do not occur in the diſſection of a human eye, and therefore are not wont to be mentioned by anatomiſts.

I HAVE obſerved in frogs, (as I preſume ſome others alſo may have done) that, beſides thoſe parts of the eye, which they have in common with men, dogs, cats, and the moſt part of other animals, they have a peculiar, whether membrane, or cartilage, or both, which ordinarily is not perceived, wherewith they can at pleaſure cover the eye, without too much hindering the ſight, becauſe this membrane is as well tranſparent as ſtrong; ſo that it may paſs for a kind of moveable *cornea*, and (if I may ſo call it) a kind of falſe-ſcabbard to the eye. In furniſhing frogs with this ſtrong membrane, the providence of nature ſeems to be conſpicuous: for they being amphibious animals, deſigned to paſs their lives in watery places, which for the moſt part abound with ſedges, and other plants endowed with ſharp edges or points, and the progreſſive motion of this animal being to be made, not by walking, but by leaping; if his eyes were not provided of ſuch a ſheath as I have been mentioning, he muſt either ſhut his eyes, and ſo leap blindly, and by conſequence dangerouſly, or, by leaving them open, muſt run a venture to have the *cornea* cut, prickt, or otherwiſe offended, by the edges or points of the plants, or what may fall from them upon the animal's eye: whereas this membrane, as was ſaid, is like a kind of ſpectacle, that covers the eye without taking away the ſight; and as ſoon as the need of employing it is paſt, the animal at pleaſure withdraws it into a little cell, where it reſts out of the way, till there be occaſion to uſe it again. This you may ſee, if you apply the point of a pin, or a pen, or any ſuch ſharp thing, to the eye of a frog, whilſt you hold his head ſteady: for, to ſcreen his eye, he will preſently cover it (at leaſt for the greateſt part) with this membrane, which, when the danger is over, he will again withdraw. And becauſe many, if not moſt ſorts of birds, are wont or deſtinated to fly, (as more would do if not kept tame) among the branches of trees and buſhes; leſt the prickles, twigs, leaves, or other parts ſhould wound or offend their eye, nature hath given them likewiſe ſuch another kind of horny membrane, as we have been mentioning in frogs.

It is known, that men, and the generality of four-footed beaſts, and of birds, have ſeveral muſcles belonging to their eyes; by the help of which muſcles they can turn them this way, or that way, at pleaſure; and ſo can obvert the organ of ſenſe to the object, whether it be placed on the right hand or the left, or above or beneath the eye. But nature having not given that mobility to the eyes of flies, (the reaſon whereof I ſhall not now ſtay to conſider) ſhe hath in recompence furniſhed them with a multitude of little protuberant parts finely ranged upon the convex of their large and protuberant eyes; ſo that by the means of the number of theſe little ſtuds (if I may ſo call them) many beams of light, that rebound from objects placed on either hand, or above, or beneath, the level of the eye, fall conveniently enough upon that organ, to make the objects they come from viſible to the animal; which you will the more eaſily believe, if you contemplate (as I have often done with great pleaſure) even the eye of an ordinary fleſh-fly, (for bees and other greater inſects have immoveable eyes too, but I find them not ſo pretty) in a good microſcope and a clear day; for you may reckon ſome hundreds of theſe little round protuberances curiouſly ranged on the convexity of a ſingle eye.

But perhaps ſome, whoſe partiality for chance makes them willing to aſcribe the ſtructures of animals rather to that, than to a deſigning cauſe, will make them draw an objection, fit to be here obviated, againſt our doctrine, from what we have obſerved of the difference between human and other eyes; ſince they will pretend, that all organs of ſight ought to be conformed to thoſe of men, as thoſe, that are the beſt and moſt perfect. It is true, that man being juſtly reputed the moſt perfect of animals, it is not ſtrange, that he ſhould (as men generally do) preſume, that his eyes and other parts of his body are the beſt contrived of any, that are to be found in nature. But yet I think we cannot from hence ſafely conclude, that all eyes, which in other animals are of ſtructures differing from thoſe of man, are for that reaſon defective. For I conſider, firſt, that the admirable wiſdom diſplayed by the author of things, in fitting the eyes and other organical parts of animals, for the uſes, that ſeem manifeſtly to have been deſigned in their fabrick, and for the reſpective functions we actually ſee them exerciſe, may juſtly perſwade us, that the things, whoſe reaſons or uſes we do not alike diſcern, are yet moſt wiſely conſtituted; ſuch an author as God having too much knowledge to do any thing unſkilfully, and we having too much preſumption, if we think he can have in the framing of his creatures no ends, that are beyond our diſcovery. And, ſecondly, we may repreſent, that the eye is not to be conſidered abſtractedly as an inſtrument of viſion, but as an inſtrument belonging to an animal of this or that kind, and who is ordinarily to make uſe of it in ſuch and ſuch circumſtances. And therefore I think it ought not at all to diſparage, but rather highly recommend, the wiſdom and providence of the great author of things, that he has furniſhed various ſpecies of animals with organs of ſight, that are very differingly framed and placed; ſince this diverſity notably manifeſts his great providence, and (if I may ſo call it) forecaſt, that has admirably ſuited the eyes of the differing kinds of animals, both to the reſt of their bodies, and (which I here mainly conſider) to thoſe parts of the great theatre of the world, on which he deſigns, that they ſhall live and act. Thus, though divers beaſts, as horſes, oxen, and ſome others, have their eyes furniſhed with a ſeventh muſcle, beſides the ſix they have in common with men; we muſt not conclude, either that the organs of viſion are imperfect in men, or that thoſe of theſe beaſts have ſomething ſuperfluous. For horſes, *&c.* being to feed for the moſt part on graſs and herbs of the field, and, that they may the better chuſe their food, being obliged to make their eyes look very long downwards; the ſeventh muſcle does excellently ſerve them to do ſo, without that wearineſs, which, if they were not furniſhed with it, that durably conſtrained poſture would be ſure to give them; whereas man, who has no ſuch neceſſity of looking aſſiduouſly downwards, would be but incumbered by a ſeventh muſcle.

On the other ſide, the defectiveneſs obſervable in the eyes of ſome animals, in compariſon of thoſe of man, may be aſcribed to the thriftineſs (if I may ſo ſpeak) of nature, that, on moſt occaſions, declines doing that, which is not neceſſary to the particular ends ſhe aims at in the fabrick of a part. Thus moles being deſigned to live for the moſt part under ground, the eyes, which nature hath given them, are ſo little, in proportion to their bodies, that it is commonly believed, and even by ſome learned men maintained, they have none at all. But though by anatomy, I, as well as ſome others, that have tried, have found the contrary; yet their eyes are very differing from thoſe of other four-footed beaſts. Which is not to be wondered at, conſidering, that the deſign of nature was, that moles ſhould live under ground, where a ſight was needleſs and uſeleſs, and where greater eyes would be more expoſed to danger; and their ſight, as dim as it is, is ſufficient to make them perceive, that they are no longer under ground, (at leaſt ſo as they are wont to be) which ſeems to be the moſt neceſſary uſe they have of light and eyes.

Zoographers obſerve, that the cameleon has a very uncommon ſtructure of his viſive organs; ſince, to omit leſſer, though not inconſiderable, peculiarities, his eyes often move independantly from one another, ſo that, for inſtance, he may look directly forward with the right eye, and with the other at the ſame time directly backwards towards his tail; or may turn the pupil of the former ſtraight upwards, whilſt he looks downwards with the other: which peculiar power ſeems to have been granted him by providence, that, being a very ſlow animal, and deſtinated to live for the moſt part in trees and buſhes, and there chiefly feed on flies; he may perceive them, which way ſoever they chance to come within the reach of his long tongue, by ſuddenly darting out of which he catches his nimble prey.

Whereas it may be obſerved, that many or moſt, if not all, meer fiſhes have the chryſtalline humours of their eyes almoſt ſpherical, as to ſenſe, and conſequently far more round than that humour is wont to be found in man, and other terreſtrial animals; this difference of figure, though it would be inconvenient in us, does very well accommodate fiſhes; ſince they living in the water, which, as a thicker medium, does much more refract the beams of light, than the air, through which they paſs to our eyes, it was fit, that the chryſtalline humour of fiſhes ſhould be very globous, that, by the help of their figure, the beams already refracted by the water, ſhould be yet ſo much refracted and made convergent, as to paint the images ſo near, as upon the bottom of the eye.

One, that being curious, had more opportunity, than I have, to ſurvey and reflect on the various ſtructures of the organs of viſion in differing animals, may, if I miſtake not, be able to find, by comparing them with the other parts of the ſame animal, and the ſcene he is deſigned to act on, and the uſes he is to make of his eyes in his moſt ordinary circumſtances; ſuch a perſon, I ſay, may be able to offer a probable reaſon of ſeveral differences in thoſe organs, that, if commonly taken notice of, would ſeem to the cenſorious to be aberrations of nature, or defects. To which purpoſe I remember, that an ingenious cultivator of optics gives this reaſon of what both he and I have taken notice of (though it be uſually overlooked) about the figure of the pupil; namely, that though it be oblong in horſes, oxen, and divers other quadrupeds, as well as in cats, yet in the former kinds of animals the pupil lies tranſverſly from the right ſide of the eye to the left, but in cats its ſituation is perpendicular; whereof he ingeniouſly gueſſes the reaſon may be, that horſes and oxen being uſually to find their food growing on the ground, they can more conveniently receive the images of the laterally neighbouring graſs, *&c.* by having their pupils tranſverſly placed; whereas cats, being to live chiefly upon rats and mice, which are animals, that uſually climb up or run down walls and other ſteep places, the commodiouſeſt ſituation of their pupil, for readily diſcovering and following theſe objects, was to be perpendicular. But it is time we proceed in our diſcourſe.

Other inſtances to the ſame purpoſe with this are elſewhere delivered; and therefore I ſhall now, to ſtrengthen the apology for divine providence, take notice, that the differing ſtructures and ſituations of the eyes in ſeveral animals are very fit to ſhew the fœcundity of the divine author's ſkill, (if I may ſo ſpeak,) in being able to frame ſo great a variety of exquiſite inſtruments of viſion. And indeed, if I may preſume to gueſs at any of God's ends, that are not manifeſt, (for other others of his ends ſeem conſpicuous,) I ſhould think, that this delightful and wonderful variety, that we may obſerve, not only in animals themſelves conſidered as entire ſyſtems, but in thoſe parts of them, that appear deſtinated for the ſame function, as particularly that of ſeeing was deſigned, at leaſt among other ends, to diſplay the multiplicity of the great creator's wiſdom, and ſhew his intelligent creatures, that his ſkill is not confined to one ſort of living engines, nor in the parts of the ſame kind, (as eyes, ears, teeth, *&c.*) to the ſame contrivances; but is able to make for the ſame uſe, a multitude of ſurpriſing organs or inſtruments, though not perhaps all equally perfect, (ſince, to do ſo, we may think he muſt make no animals but men,) yet all of them curious and exquiſite in their kinds, and in order to their differing ends. To be able to frame both clocks, and watches, and ſhips, and rockets, and granadoes, and pumps, and mills, *&c.* argues and manifeſts a far greater ſkill in an artificer, than he could diſplay in making but one of thoſe ſorts of engines, how artificially ſoever he contrived it. And the ſame ſuperiority of knowledge would be diſplayed, by contriving engines of the ſame kind, or for the ſame purpoſes, after very differing manners. As weights indeed are of great uſe and neceſſity in the famous clock of *Straſburg*; and therefore it recommends the inventors of watches, not only that they can make clocks of a very little and eaſily portable bulk, which the *Straſburg* machine is not, but can make a clock without weights, and by means of a ſpring perform their office. And thus, though to fly it ſeems abſolutely neceſſary, that an animal ſhould be furniſhed with feathers, the wiſe creator hath ſhewn, that he is not confined to make uſe of them for that purpoſe; ſince a flying fiſh is able to move a great way in the air; and the Indies have lately furniſhed us with a ſort of flying ſquirrils, whereof I ſaw one alive at *Whitehall.* And though the flight of theſe is not long, yet there is another kind of animals without feathers, that can fly long enough, namely the batt; though ſome of theſe, as I have ſeen, be little leſs than hens: and I have been aſſured by a credible eye-witneſs, that in the kingdom of Golconda he had ſeen much bigger.

But though this conſideration may ſuffice to juſtify the wiſdom of the creator, who being an agent moſt free, as well as moſt wiſe, men ought not to find fault, if he think fit to recommend his wiſdom by diſplaying it in very different manners; yet this is not all that may be ſaid on this occaſion. For there are many caſes, and perhaps far more than we imagine, wherein the peculiar, and in ſome regards leſs perfect, fabric or ſituation of an eye or other organical part, may be more convenient, than the correſpondent organ of man, to attain the ends, for which it was given to an animal, that was to act upon ſuch a theatre, and live by ſuch proviſion. Beſides that an organical part may, in ſome animals, be intended for more uſes than in others, and therefore may require a differing ſtructure, as in moles, the feet are otherwiſe framed or ſituated, than in other quadrupeds, becauſe the chief uſe they were to make of them was not to walk upon the ground, but to dig themſelves ways under ground; the provident δημιουργὸς wiſely ſuiting the fabric of the parts to the uſes, that were to be made of them: as a mechanic employs another contrivance of his wheels, pinions, *&c.* when he is to grind corn with a mill, that is to be driven by water, than when he is to do the ſame thing by a mill, that is to be moved by the wind. And the cameleon has a tongue, both peculiarly ſhaped, and of a length diſproportionate to that of his body, becauſe he was to take his prey by ſhooting out (if I may ſo ſpeak) his tongue at the flies he was to live upon, and could not often approach them very near without frighting them away. And in many caſes, in which this reflection does not ſo properly take place, we may obſerve, that there is a wonderful compenſation made for that, which ſeems a a defect in the parts of an animal of this or that particular ſpecies, compared with the correſpondent ones of a man, or an animal of ſome other ſpecies.

Thus birds, that (except the batt, and and one or two more) want teeth to chew their food, are not only furniſhed with hard bills to break it; and birds of prey, as hawks, *&c.* with crooked ones to tear it; but, which is more conſiderable, have crops to prepare and ſoften it, and very ſtrong muſcular ſtomachs to digeſt and grind it: in which work they are uſually helped by gravel and little ſtones, that they are led by inſtinct to ſwallow, and which are often found (and ſometimes in amazing numbers,) in their ſtomachs, where they may prove a vicarious kind of teeth.

I shall hereafter have occaſion to ſay ſomewhat more againſt their opinion, that find fault with thoſe animated ſtructures, that we think to be productions of the divine wiſdom, under pretence, that the parts of ſome living creatures are not ſo curious and ſymmetrical, as not to have been caſually producible. But, in the mean time, I ſhall here note, for thoſe, that aſcribe ſo much to chance, that chance is really no natural cauſe or agent, but a creature of man's intellect. For the things, that are done in the corporeal world, are really done by the parts of the univerſal matter, acting and ſuffering according to the laws of motion eſtabliſhed by the author of nature. But we men, looking upon ſome of theſe parts as directed in their motions by God, or at leaſt by nature, and diſpoſed to the attainment of certain ends; if by the intervention of other cauſes, that we are not aware of, an effect be produced very differing from that, which we ſuppoſed was intended, we ſay, that ſuch an effect was produced by chance. So that chance is indeed but a notion of ours, and ſuch a thing, as a ſchoolman might call an extrinſical denomination, and ſignifies but this; that in our apprehenſions the phyſical cauſes of an effect did not intend the production of what they nevertheleſs produced. And therefore I wonder not, that the philoſophers, that preceded *Ariſtotle*, ſhould not treat of chance, among natural cauſes; as we may learn from *Ariſtotle* himſelf, who is more juſt to them in ſuſpecting they owned not ſuch a cauſe, than in taxing them of an omiſſion for not having treated of it.

And on this occaſion I ſhall only add, before I proceed, that whereas ſome of the moſt curiouſly ſhaped kind of ſtones, as the *Aſtroites*, have emboldened many of the favourers of *Epicurus* to bring them into competition with theſe animals, or parts of animals, from their likeneſs to which they have received their names; it is fit to be conſidered, firſt, that ſome learned men have of late made it very probable, that ſome of the curiouſeſt ſorts of theſe ſtones were once really the animals, whoſe ſhapes they bear, or thoſe parts of animals, which they reſemble; which animal ſubſtances were afterwards turned into ſtones, by the ſupervening of ſome petreſcent matter, or petrifying cauſe; of which metamorphoſis I have met with, and do elſewhere mention, more inſtances, than are fit to be ſo much as named in this place. Secondly, though ſome of thoſe ſorts of ſtones were the production of the mineral kingdom, (for I will not be dogmatical in this point;) yet, beſides that it would not clearly follow, that they owe their ſhapes to chance, ſince there is no abſurdity to admit ſeminal principles in ſome more elaborate ſorts of foſſiles; I think it would be very injurious to make theſe productions vie with the animals, to which they are compared. For the reſemblance of ſhapes, wherein alone they and the animals agree, being but the outward figure, is but a ſuperficial thing, and not worthy to be mentioned, in compariſon of that, wherein they differ; the rude and ſlight contexture of the beſt ſhaped ſtones, being incomparably inferior to the internal contrivance of an animal, which muſt conſiſt of a multitude of parts, of ſuch a figure, bulk, texture, ſituation, *&c.* as cannot but be obvious to any, that have ſeen diſſections ſkilfully made. And it is not only in the ſtable and quieſcent parts, that this great internal difference between ſtones, and the animals they reſemble, is to be found; but there is in a living animal a greater difference, than any of the knives of anatomiſts can ſhew us in a dead one betwixt a ſtone, though never ſo curiouſly figured, and an animal. For there are, I know not how many, liquors, ſpirits, digeſtions, ſecretions, coagulations, and motions of the whole body, and of the limbs and other parts, which are lodged and performed in a living body, and not in a cadaver; and are perchance far more admirable, even than the ſtructure of the ſtable and quieſcent parts themſelves. So that though a ſtone, outwardly very like a ſhell-fiſh, were made by chance; yet from thence to conclude, that chance may make a real living ſhell fiſh, would be to argue worſe than he, that ſhould contend, that becauſe even an unſkilful ſmith may make a hollow piece of metal like a watch caſe, though he can fill it but with filings of iron, or ſome other rude ſtuff, he muſt be able to make a watch; there being leſs difference betwixt the ſkill expreſſed in making the caſe of a watch and the movement, than in making a body like a ſhell, and the internal parts of a real fiſh: or to ſay, that becauſe putrefaction and winds have ſometimes made trees hollow, and blown them down into the water, where they ſwim like boats; therefore the like cauſes may make a galley built and contrived, as well within as without, according to the laws of naval architecture, and furniſhed with mariners to row it, ſteer it, and, in a word, to excite and guide all its motions to the beſt advantage, for the preſervation and various uſes of the veſſel. In ſhort, if chance ſometimes does ſome ſtrange things, it is in reference to what ſhe herſelf, but not to what nature, uſes to perform.

And now, to give you the ſummary of my thoughts, about the ſecond queſtion; 1. I think, that from the ends and uſes of the parts of living bodies the naturaliſt may draw arguments, provided he do it with due cautions, of which I ſhall ſpeak under the fourth queſtion. 2. That the inanimate bodies here below, that proceed not from ſeminal principles, have but a more parable texture, (if I may ſo ſpeak) as earths, liquors, flints, pebbles, and will not eaſily warrant ratiocinations drawn from their ſuppoſed ends. 3. I think the cœleſtial bodies do abundantly declare God's power and greatneſs, by the immenſity of their bulk, and (if the earth ſtand ſtill) the celerity of their motions, and alſo argue his wiſdom and general providence as to them; becauſe he has for ſo many ages kept ſo many vaſt vortices, or other maſſes of matter, in ſcarce conceivably rapid motions, without deſtroying one another, or loſing their regularity. And I ſee no abſurdity in ſuppoſing, that, among other uſes of the ſun, and of the ſtars, the ſervice of man might be intended; but yet I doubt, whether, from the bare contemplation of the heavens and their motions, it may be cogently inferred, at leaſt ſo ſtrongly as final cauſes may be from the ſtructure of animals, that either the ſole or the chief end of them all is to enlighten the earth, and bring benefits to the creatures, that live upon it.

In what has been hitherto ſaid on our ſecond queſtion, it is plain, that I ſuppoſe the naturaliſt to diſcourſe meerly upon phyſical grounds. But if the revelations contained in the holy ſcriptures be admitted, we may rationally believe more, and ſpeak leſs heſitantly, of the ends of God, than bare philoſophy will warrant us to do. For if God is pleaſed to declare to us any thing concerning his intentions, in the making of his creatures, we ought to believe it, though the conſideration of the things themſelves did not give us the leaſt ſuſpicion of it; which yet in our caſe they do. And therefore a late ingenious author did cauſleſly reflect upon me, for having mentioned the enlightning of the earth, and the ſervice of men, among the ends of God, which he thought undiſcoverable by us. For whether or no we can diſcover them by meer reaſon, as divers of the heathen philoſophers thought they did; yet ſure we may know thoſe, that God is pleaſed to reveal to us: and the perſons I argued with were apparently ſuch, as admitted the authority of the ſcriptures; which expreſly teach us, that God made *the two great luminaries*, (for ſo I ſhould render the Hebrew words את־שני המאורת הערלים) *the greater for the rule of the day, and the leſſer for the rule of the night*. And that *he made the ſtars alſo*, and ſet them in the firmament, or rather expanſum of the heaven, *to give light upon the earth*. And a little above, among the uſes of the luminaries theſe are reckoned, *to divide the day from the night, and to be for ſigns, and for ſeaſons, and for days and years*. And in another place, the prophet *Moſes* dehorting the Iſraelites from worſhipping the ſun, the moon, and the ſtars, tells them, that the *Lord had imparted them unto all nations under the whole heaven*. And therefore thoſe Carteſians, that, being divines, admit the authority of holy ſcripture, ſhould not reject the conſideration of ſuch final cauſes, as revelation diſcovers to us; ſince it is certainly no preſumption to think we know God's ends, when he himſelf acquaints us with them; nor to believe, that the ſun, though it be generally eſteemed to be a nobler body than the terreſtrial globe, was made, among other purpoſes, to give light to its inhabitants. It is recorded in the book of *Geneſis*, the deſign of God in making man was, that *men* ſhould *ſubdue the earth* (as vaſt a globe as it is) *and have dominion over the fiſh of the ſea, and over the fowl of the air, and over the cattle, and over all the earth*, and (to ſpeak ſummarily) *over every living thing, that moveth upon the earth*. And the ſame book informs us, that after the deluge, God *delivered all terreſtrial beaſts, and fowl, and fiſhes, and every moving thing, that lives*, into the hands of men; and intended, that they ſhould eat animals, as before the flood he had appointed them all the ſorts of wholeſome vegetables for their food. And

Gen. i. 16.

Deut. iv. 19.

Gen. i. 26, 27, 28.

Gen. ix. 23.

And ſince God was pleaſed to appoint, that men ſhould live on theſe creatures, it cannot be abſurd to ſay, that, among other purpoſes, to which he deſtinated the ſun, his ſhining upon the earth was one; ſince without his light and heat, men could not provide for, or enjoy themſelves; and neither thoſe plants, that men and cattle muſt live upon, could grow and ripen; nor (conſequently) thoſe animals, that were to be their principal food and ſerve them for many other uſes, could be ſuſtained and provided for. Many other texts, that ſhew, how much God was pleaſed to intend man's welfare, and dominion over many of his fellow-creatures, might be here alledged. But I ſhall content myſelf to mention, what the kingly prophet ſays in the 8th pſalm, where ſpeaking of man to his maker, he ſays; Pſalm viii. 5, 6. *Thou haſt made him a little lower than the angels, and haſt crowned him with glory and honour. Thou madeſt him to have dominion over the works of thine hands, and haſt put all things under his feet.* Indeed if in man we conſider only that viſible part, his body; the ſmallneſs of it may make it thought improbable, that portions of the univerſe incomparably greater than he, ſhould be at all intended to be ſerviceable to him. But Chriſtians ought not to think this incredible, if they conſider man, as he chiefly conſiſts of a rational mind, which proceeds immediately from God, and is capable of knowing him, loving him, and being eternally happy with him. They, that deſpiſe man conſidered in this capacity, do very little know the worth of a rational ſoul; and eſtimate things like maſons, and not like jewelers, who juſtly value a diamond no bigger than a bean, more than a whole quarry of ordinary ſtones. And particularly to thoſe undervaluers of their own ſpecies, that are divines, it may be repreſented, that God, who will not be denied to be the beſt judge in this caſe, as in all others, was pleaſed to conſider men ſo much, as to give *David* cauſe to admire it in the words lately cited; and not only to endow them with his image at their firſt creation, but when they had criminally loſt and forfeited it, he vouchſafed to redeem them by no leſs than the ſufferings and death of his own ſon, who is incomparably more excellent than the whole world. And it is not incredible, that God ſhould have intended, that many of his other works ſhould be ſerviceable to man; ſince by miraculous operations he hath ſometimes ſuſpended the laws of nature, and ſometimes over-ruled them, upon the account of man: as may appear by *Noah*'s flood; by the paſſage of the *Iſraelites* on dry land through the Red Sea, and the river of *Jordan*; by the ſtanding ſtill of the ſun and moon (or the terreſtrial globe) at *Joſhua*'s command; by the inefficacy of the burning fiery furnace on *Daniel*'s three companions; and (to be ſhort) by the ſtupendous eclipſe of the ſun at the full moon, at the crucifixion of the *Meſſias*. To which I might add, that the chief part of mankind, namely the children of God, will, by their moſt bountiful remunerator, be thought fit to inhabit the new world (for that, by an Hebraiſm, is meant by the *new heavens and the new earth* St. *Peter* 2 Pet. iii. 10, 11, 12, 13. ſpeaks of) which ſhall ſucceed the renovation and refinement of the preſent world by the laſt fire, that will not only diſſolve, but, if I may ſo ſpeak, transfigure it.

AND we ſhall the leſs ſcruple to admit, that ſuch vaſt and bright bodies as the ſun and moon may be deſigned (among other things) to be ſerviceable to men, if we conſider, that it is ſo far from being a conſtant rule, that a thing more excellent cannot (by a wiſe agent) be employed for the good of one, that is leſs ſo, that not only the firſt angel, whoſe apparition we read of in the ſcripture, was ſent to relieve *Hagar*, a ſlave wandring in a Gen. xvi. 9, &c. wilderneſs; another had regard to the life of a ſooth-ſayer's aſs; and many others (and Num. xxii. 23. ſometimes companies of them) were employed on earth to do good offices to particular perſons: Gen. xxxii. 1, 2. 2 Kings 6, 17. but of all the angels in general, the excellent epiſtle to the *Hebrews* informs us, That they *are miniſtring ſpirits,* Heb. i. 14. *ſent forth to miniſter unto them, who ſhall be heirs of ſalvation.*

SECT. III.

TO handle the third queſtion, * it will be neceſſary for us to clear the grand difficulty, that has, ever ſince *Ariſtotle*'s time, and even before that, perplexed thoſe, that allow in natural philoſophy the conſideration of final cauſes. The difficulty is obvious enough; for much the greater part of bodies being void of knowledge, and moſt of them (as all inanimate bodies) of life itſelf, it ſeems not conceivable, how they ſhould act conſtantly for ends they are not capable of pre-deſigning, and appoſitely employ means, that they have no knowledge, wherewith to make choice of.

ARISTOTLE, who expreſly teaches, that Vid. Ariſt. de Cœlo, l. II. c. 5. & eund. de Gen. & Interitu l. II. c. 10. nature does nothing in vain, and rightly judged, that the actions of natural agents tended to certain ends, takes notice of this difficulty, but ſeems rather to ſhift it off than reſolve it; the ſolution he frames regarding ſo peculiarly the words, wherein he has expreſſed the objection, that I much doubt, whether it would ſignify much to clear the ſame difficulty propoſed in other terms: and to me he ſeems to ſpeak ſo darkly, not only in his tranſlator's Latin, but in his own Greek, that, if he have given a good ſolution of the difficulty, I muſt ingeniouſly confeſs my dullneſs, in not being able to underſtand it.

BUT, to conſider the difficulty itſelf, there are two accounts, on which the actions of natural agents may be ſaid, to tend to a certain end: one, when the agent has a knowledge of that end, and acts with an intention to obtain it; as when a man ſhoots an arrow to hit a mark: the other is, when the action of the proximate agent is indeed ſo directed, as it ought to be to obtain an end, and yet that end is neither known nor intended by the proximate agent, but by a remoter agent, that is intelligent. In the former of theſe ſenſes I cannot admit, that (not now to examine, whether any living, but not rational works of nature may) any inanimate bodies can act for an end; for to do ſo, preſuppoſes, that the agent both knows the end he is to attain, and purpoſes to attain it; which are things, whereof inanimate bodies are uncapable. And to fancy with ſome, that they may have a knowledge *ſui generis*, (as they ſpeak) which, though confined to the actions proper to this or that particular kind of body, is yet ſufficient to determine to thoſe actions, is to offend againſt that rational and received rule of philoſophizing, *Entia non ſunt multiplicanda ſine neceſſitate*, and to introduce a ſort of knowledge, which I fear the propoſers do not well conceive, or, at leaſt, I am ſure I do not.

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* Viz. *Whether, and in what ſenſe, the acting for ends may be aſcribed to an unintelligent, and even inanimate body?*

It remains then, that I embrace the ſecond ſenſe, in which we formerly ſaid, that natural things may be ſaid to work for an end; though indeed in this caſe, we muſt ſpeak ſomewhat improperly: for, by him, that conſiders, the action will be oftentimes more juſtly attributed to the intelligent, but remoter, than to the immediate agent, which is but, as it were, the inſtrument of the other. But how this is poſſible to be done, appears difficult to be explained. To me it ſeems, it may be thus conceived: the moſt wiſe and powerful Author of nature, whoſe piercing ſight is able to penetrate the whole univerſe, and ſurvey all the parts of it at once, did, at the beginning of things, frame things corporeal into ſuch a ſyſtem, and ſettled among them ſuch laws of motion, as he judged ſuitable to the ends he propoſed to himſelf in making the world: and as by virtue of his vaſt and boundleſs intellect, that he at firſt employed, he was able not only to ſee the preſent ſtate of things he had made, but to foreſee all the effects, that particular bodies ſo and ſo qualified, and acting according to the laws of motion by him eſtabliſhed, could in ſuch and ſuch circumſtances have on one another; ſo by the ſame omniſcient power, he was able to contrive the whole fabric, and all the parts of it, in ſuch manner, that, whilſt his general concourſe maintained the order of nature, each part of this great engine, the world, ſhould, without either intention or knowledge, as regularly and conſtantly act towards the attainment of the reſpective ends which he deſigned them for, as if themſelves really underſtood, and induſtriouſly proſecuted thoſe ends. Juſt as in a well made clock, the ſpring, the wheels, the balance, and the other parts, though each of them act according to the impulſes it receives, and the determination, that is given it, by the other pieces of the engine, without knowing what the neighbouring parts, or what themſelves do; yet their tendencies are ſo determined, and ſometimes over-ruled, and their motions ſo quickened, by the ſtructure of the clock, that they would not move more conveniently, nor better perform the functions of a clock, if they knew, that they were to make the index truly mark the hours, and intended to make it do ſo. It is true, that it is not eaſy to conceive, how one agent ſhould, by ſo ſimple an inſtrument as local motion, be able to direct a multitude of agents, as numerous as the bodies, that make up a world, to act as regularly, as if each of them acted upon its own particular deſign, and yet all of them conſpired to obey the laws of nature. But if we conſider, that it is to God, that is an omniſcient and almighty Agent, that this great work is aſcribed, we ſhall not think it incredible; eſpecially if we conſider, that, whereas it is manifeſt enough, that a multitude of bodies act, as we have ſuppoſed, if we will not aſcribe the direction and ſuper-intendence of the motions, that are manifeſtly fitted for the attainment of ends unto God, we muſt do it to nature, which will not leſſen, but increaſe the difficulty: and when I have ſeen, as, ſometimes I have, with pleaſure, a great engine, wherein the works of I know not how many trades, and a great many other motions, were performed by little puppets, that managed the tools of the artificers; and all theſe were ſet a work by one ſpring, which communicated motions, that were regulated and determined by the particular ſtructure of the little ſtatues and other bodies: when, I ſay, I conſider ſuch things as theſe, I cannot think it impoſſible, that the divine and great Δημιουργὸς, as both philoſophers and ſacred writers have ſtiled the world's Creator, ſhould be able, by the motions and ſtructure of matter, to ſet a work very many partial and ſubordinate engines. For it will not, I hope, be denied, that the multitude of theſe does not any thing near ſo much ſurpaſs the number of thoſe, which I ſaw in the hand of an illiterate tradeſman, as the narrow knowledge of that artificer is ſurpaſſed by the boundleſs underſtanding of an omniſcient artiſt. And it is more, in the making ſo many and ſo various bodies act according to their particular deſignations, and and yet all of them conſpire to the general ends of the univerſe, that God's wiſdom, and (if I may ſo ſpeak) his ſkill is diſplayed, than barely in the making bodies act appoſitely for ends to themſelves unknown. For if moving bodies be duly diſplayed, and have a ſufficient connection, it is not difficult to direct a few of them to the attainment of an end propoſed by an underſtanding agent, though unknown to the immediate agents: as antiently among the Jewiſh huſband-men, (and at this day in ſome parts of the Eaſt) the ox, that intended no ſuch matter, did, by treading the corn, as well ſeparate the grain from the ſtraw, as our plowmen do,

Heb. xi. 10.

when they threſh it purpoſely to make that ſeparation: and a horſe or an aſs in a mill may as well, by his going round, grind the corn, as the miller himſelf could do.

Nor is this doctrine inconſiſtent with the belief of any true miracle; for it ſuppoſes the ordinary and ſettled courſe of nature to be maintained, without at all denying, that the moſt free and powerful Author of nature is able, whenever he thinks fit, to ſuſpend, alter, or contradict thoſe laws of motion, which he alone at firſt eſtabliſhed, and which need his perpetual concourſe to be upheld.

The laws of method would oblige me to conclude here this ſection, and paſs to another; but in regard, that all I thought my ſelf obliged to ſay about it, leaves it ſo very ſhort, as to be very diſproportionate in bulk to the other ſections of this diſcourſe, I will crave leave to lengthen it in this place, with ſomething, which, though it may be judged to belong more properly to another, will not perhaps be thought to be impertinent here; and much leſs to be uſeleſs to the deſign of this diſcourſe.

Here then you may pleaſe to take notice, that in all that I have diſcourſed in the ſecond ſection, or may elſewhere have occaſion to ſay, againſt the received opinion, that the whole material world was made for man, I would not be underſtood to ſpeak either too dogmatically, or too excluſively; my deſign being to deliver, what I thought might probably be repreſented to take off the prejudice, that men are generally prepoſſeſſed with in their own favour. For though the arguments I alledge againſt the vulgar opinion, ſeem as yet to me more probable, than thoſe I have hitherto met with for it, eſpecially as it relates to the vaſt celeſtial region of the world; yet I am not only willing to grant, that, among the ends deſigned by the Author of nature, in ſeveral of his works, eſpecially plants, animals and metals, the utility of men may be one, and perhaps one of the principal; but I am not averſe from thinking, that human ends, (or uſes, that relate to men) may have been deſigned by God in ſeveral creatures, whoſe human uſes men are not yet aware of; and that he may have intended, that of ſeveral of his creatures, whereof men do already know, and make ſome uſes, they ſhall hereafter diſcover other utilities, and perhaps nobler ones.

Those, that reflect on the providence of God, whilſt they repreſent, what they call nature, as a ſtep-mother to man, whom ſhe brings naked, toothleſs, and helpleſs into the world, whilſt ſhe furniſhes the new-born fœtus's of brutes with wooll or other clothing, and both with a power to walk and ſeek their food, and (as to many of them) with teeth to eat it: thoſe men, I ſay, have been long ago anſwered by the eloquent *Lactantius*, and other champions of Providence. And therefore I ſhall only add this, that God, by giving man neceſſity and reaſon, has effectually excited him, and richly furniſhed him with ability, to procure for himſelf far greater accommodations and advantages, than thoſe beaſts come into the world with; and by vouchſafing him that noble faculty of underſtanding, he has put it in his power to convert to his own uſe thoſe very things, for which profane wits would have the condition of beaſts preferable to his. For man, by his reaſon employing ſkilfully ſuch admirable inſtruments as his hands, is able to maſter and apply to his own uſes the fierceneſs of ſeveral wild beaſts, as leopards, (which the Perſians hunt with) the vaſt ſtrength of elephants, the huge bulk of whales, the ſagacity of ſpaniels, hounds, and ſetters, the ſwiftneſs of grey-hounds, the ſubtlety of tumblers, and the furs of beavers, martins, *&c.* to omit a multitude of others, which God, by the ſingle gift of reaſon to man, has enabled him to maſter and make uſe of to his own advantage. And though at firſt he be helpleſs enough, and unable to exerciſe his dominion over inferior creatures, yet God has ſufficiently provided for him, by giving his parents, whilſt he needs them, that ϛοργὴ natural affection for him, which engages them to take care of him, till he be in condition to take care of himſelf, and become qualified to obtain ſuch knowledge and induſtry, as may make him poſſeſſor of the advantages, whereof his indulgent and bountiful Creator made him capable.

Those moderns, that think it ridiculous to imagine, that, in framing ſuch vaſt bodies as the earth, and ſome of the celeſtial globes, their Creator ſhould have any regard to ſo ſmall a part of the earth as man, and deſigned, that they ſhould be ſome way or other ſerviceable to him, look upon things rather as ſurveyors, who conſider mainly their extent, than as philoſophers, that eſtimate them by their intrinſic value. For though it be true, that man, conſidered barely as an animal, is a creature little enough to be contemptible; yet as he is endowed with a ſoul immaterial, rational, and immortal, he is a creature much more noble and excellent than the whole terraqueous globe, or a much vaſter maſſe of corporeal ſubſtance, that is ſtupid and inanimate. For the rational ſoul is capable of underſtanding, and willing, (which are higher faculties than mere matter can reach to) and which is more, of knowing, ſerving and enjoying God. And man being the only viſible creature, that is capable to underſtand the wiſdom, power, and beneficence of God in the creation, and in many ways to ſubdue a great variety of the other creatures, and apply them to his uſes; it ought not to ſeem ſtrange, that the wiſe Author of the univerſe, that made all things ſo as to bring glory to himſelf, ſhould have a more eſpecial regard to ſo noble a piece of his workmanſhip, than to any, that, being merely corporeal, can neither underſtand his wiſdom and his power, nor render him thanks nor praiſes for the manifold and admirable effects of them. And that littleneſs, that is alledged to make man a contemptible creature, is ſo far from being a diſparagement to that noble part of him, the ſoul, which makes him a man, that is, a rational creature; that its excellency conſiſts in being leſs than the minuteſt body; ſince, not having extenſion, it is not diviſible; which is the prerogative of ſubſtances, which, for that reaſon, are immaterial and immortal.

This mention of the human mind leads me to a further reflection, which is, that many parts of the material world, whereof man has not been known to make any advantage in the capacity of a mere animal, may yet be highly uſeful to him, as he is a rational creature, that is, capable, by contemplating the great and admirable works of God, to raiſe his mind to the acknowledgment of the divine Architect's power, wiſdom and beneficence, and thereby find produced in him due ſentiments of veneration, gratitude, and love. And theſe may be ſafely reckoned among thoſe ends or uſes, which in the firſt ſection we have ſtiled human ones; ſince ſome of the Heathen philoſophers themſelves called the world a temple, and one of the more philoſophical fathers of the church, loftily ſtiles it, παιδευτήριον τῆς θεογνωσίας, ϗ ψυχῶν λογικῶν διδασκαλεῖον.

And indeed we find, that the pſalmiſt alone may furniſh us with divers inſtances to our preſent purpoſe: for not only he teaches us that *the heavens declare the glory of God*, and that in a language, that, notwithſtanding what happened at *Babel*, reaches to all the nations of the world; but he employs the contemplation of God's viſible works, to excite in himſelf and others true ſentiments, both of devotion and of particular virtues. Thus the conſideration of his having been wonderfully formed in his mother's womb, moves him to revere and celebrate the admirable ſkill of the Opificer. Elſewhere the conſideration of the regular viciſſitudes obſervable in the courſe of nature, invite him to admire and extol the providence of God. And when in another place, he beholds thoſe vaſt bodies and ſhining ones, that compoſe and adorn the cœleſtial part of the world, he juſtly falls into ſentiments of great humility and deſerved gratitude.

Pſal. xix. 1, 2, 3.

Pſ. cxxxix. 14.

Pſal. civ. *throughout, eſpecially* ver. 24.

Pſal. viii. 3, 4.

And as to this uſe, the diſtance and vaſtneſs of the fixed ſtars, the immenſity of the heavens, and the regular motion of the ſuperior planets, (ſuppoſing they can bring man no other advantage) may do him good ſervice, ſince they afford him rational and ſolid grounds to believe, admire, adore, and obey the Deity. For by thus ſpiritualizing (if I may ſo ſpeak) the corporeal works of God, there may accrew to the pious ſoul uſes far more valuable, than they can afford the body; ſince they will perfectionate the mind here, and continue to be advantageous to it, when the body will not need the world, and the world itſelf, as to its preſent conſtitution, ſhall be deſtroyed.

But to proceed from this uſe of the world, which is theological, to a human uſe, that is more phyſical, as relating to the preſent welfare of man, as he is an animal, as well as a rational creature; I ſhall repreſent, that as a nation is oftentimes, in the account of providence, conſidered as one man, notwithſtanding its various diſperſions, and perhaps long continuance; as the Iſraelitiſh people, during many ages, notwithſtanding its diviſions and captivities, was addreſſed to and treated, by the prophets and apoſtles commiſſioned by God, as one perſon, named *Iſrael*, whom God, ſometimes in the ſcripture, is pleaſed to call his ſon: ſo perhaps it will not be abſurd to conceive, that mankind itſelf may in ſome regards, or as to ſome purpoſes, be looked upon, by its author, as one man, who, by ſucceſſive improvements of his knowledge, may, from time to time, be enabled to make new and conſiderable uſes of the things, that the wiſe and bountiful providence of his Maker had framed with a foreſight that he would, and with intention that he might, make them advantageous to him. And therefore it cannot ſafely be concluded that every thing, whoſe uſefulneſs to man is not yet obvious, nay, that every thing, that ſeems hurtful to him, can never be made beneficial to him. For we ſee, that opium was, for many ages, looked on only as a poiſon, but now is employed as a noble remedy, (as indeed it is, if ſkilfully prepared, and judiciouſly exhibited) in many violent, and oftentimes dangerous diſtempers. Vipers are venomous animals, but yet their fleſh is a main ingredient of that famous antidote treacle; and being in great part diſſolved in tract of time in good Spaniſh wine, I have tried it with ſurpriſing ſucceſs, in an uncommon and very difficult caſe. Scorpions alſo afford, by bare infuſion, an oil that not only cures their own ſtings, but is very available in ſeveral diſtempers. And I remember, that a learned profeſſor of *Padua* having cured the widow of a ſovereign prince of a fit of the ſtone, anſwered me ſome few days after, that the chief remedy he employed and relied on, was a preparation (which he intimated to conſiſt mainly in a light kind of calcination) of ſcorpions, which, ſomewhat to my wonder, he made his patient take inwardly. And, though the roots of maudioca be reckoned among poiſons, when the juice is in them, of which I elſewhere relate a notable inſtance; yet when the juice is preſſed out, and the firm part reduced to meal, it affords the caſſava, which is the common bread of a great part of the Americans; and I did not ſcruple to eat of it here in *England*: nay, the poiſonous juice itſelf, in divers places of the Weſt Indies is, even by the unſkilful inhabitants, turned into an ordinary, and, by them, beloved drink. But enough of this ſort of inſtances. I ſhall be more brief in thoſe of another kind, whereof the firſt is afforded by the loadſtone, which though, for many ages, admired by the Greeks and Romans, for what is commonly called its attractive virtue, had not its directive virtue known, at leaſt any thing vulgarly, in theſe parts of the world, till within leſs than four ages; ſince when, of what vaſt uſe this ſtone

Exod. iv. 22.

Hoſ. xi. 1.

has proved to mankind, the diſcovery of the Weſt Indies, and of the way of ſailing by the Cape of Good Hope to the Eaſt Indies, ſufficiently declares. I will ſay nothing of the uſes of the ſilk-worm, and the ſugar-cane, which were little taken notice of for many ages, even by the civilized and luxurious Greeks and Romans; but now, together with the lately diſcovered cocheneal, which is but an inſect, and far leſs than the ſilk-worm, make a good part of the trade of Europe, and furniſhes the tables of the delicate with ſweet meats, and the courts of princes with many of their fineſt ornaments. But not to inſiſt on ſuch things as theſe, but to proceed.

It deſerves alſo to be conſidered, on this occaſion, that many things, that are not thought uſeful to men, becauſe we ſee not, that they directly bring in any immediate advantages, may yet be of great uſe to them, as they miniſter to, or are neceſſary for other things that are very ſerviceable to them. As the exceſſive rains, that cauſe the over-flowings of rivers in divers parts of *Africk*, and ſome other countries, though they ſeem rather deſtructive than profitable, do yet, by their ſeaſonable inundations, make *Egypt*, and ſome other countries, exceedingly fertile, that without them would be very barren: and among us, thoſe clouds, that do us no immediate ſervice, do oftentimes, by watering our fields and gardens in ſummer, and by manuring them, as it were, in winter, nouriſh thoſe trees, graſs, corn, herbs, and other plants, whereof ſome ſerve immediately for aliments to man, and others are neceſſary for the nouriſhment of ſheep, oxen, deer, and other beaſts, that men uſually feed upon.

Not only plants and animals, and ſtones and metals, and ſuch other ſmaller bodies, as are within man's reach, are capable of being made uſe of by him; but, to advance a ſtep farther, to far greater maſſes of matter, and even ſome of thoſe remote cœleſtial globes, which he is thought able only to contemplate; one of thoſe ends, to which the indulgent Creator deſtinated them, may be to be ſerviceable to man.

To ſay nothing of the advantage, that ſkilful ſeamen make of the ebbing and flowing of that vaſt collection of waters, the ocean; the declination of the mariner's needle, and the variation of it, which probably depends upon the motions or changes of ſome vaſt internal portion of the terraqueous globe, is found to be of great uſe by experienced pilots and navigators, in their voyages through thoſe vaſt ſeas they uſe to paſs between Europe and the Eaſt Indies; as I learned by particular inquiry from eminent perſons, that have more than once ſailed upon thoſe ſeas. The moon, to omit her light, ſerves men, not only to make moon-dials by, and to foretel regularly the times and quantities of the various ebbings and flowings of the ſea, the knowledge of which is very beneficial, if not neceſſary, to mariners, but ſerves mathematicians for divers other purpoſes. The ſun, not to mention his ordinary light and heat, and the neceſſity of them to the plants and animals, that afford man food and medicines, and to the production of many other effects, whereon his welfare depends, do enable him, by concave and convexed glaſſes, to burn with cœleſtial beams, without the help of culinary fire; and enable the gnomoniſt to make acurate dials, to know exactly how the time paſſes; the coſmographer to make very uſeful diſcoveries of the elevation of the pole, and latitudes of places; and the heedful obſerver of his riſing and ſetting, to diſcover what artiſts call his amplitude, which is of good uſe to aſtronomers, and more to navigators, by helping them to eſtimate, among other things, the variation of the compaſs, (from true north and ſouth points.) And the conjunction or oppoſition of the ſun and moon in eclipſes, though it be a frightful thing to the ſuperſtitious vulgar, yet to knowing men, that can ſkilfully apply them, theſe eclipſes are of great uſe, and ſuch as common heads would never have imagined; ſince not only they may, on divers occaſions, help to ſettle chronology, and rectify the miſtakes of hiſtorians, that writ many ages ago; but, which is, though a leſs wonder, yet of greater utility, they are, as things yet ſtand, neceſſary to define, with competent certainty, the longitude of places or points aſſigned on the terraqueous globe, which is a thing of very great moment, not only to geography, but to the moſt uſeful and important art of navigation. And laſtly, at how ſtupendous a diſtance ſoever the fixed ſtars are placed, yet their remoteneſs cannot hinder the induſtry of man from making even theſe ſerviceable to his uſes; ſince, if we ſhould admit thoſe determinate cœleſtial influences, that are little leſs than the idols of aſtrologers, they would enable us to predict the changes of weather, the fertility and dearth, the ſicklineſs, or healthineſs, of any propoſed ſeaſon: and, not to lay any ſtreſs upon ſo controverted a ſcience, it is plain, that ſkilful navigators can make uſe of any of the fixed ſtars, to know by any of them, what hour it is of the night: and it is more known, that fiſhermen and pilots did generally, for many ages, till within theſe four laſt centuries, make very great uſe of the pole-ſtar, and other of the northern fixed ones, to guide them, when nothing elſe could, in the perilous courſes of their navigations.

I have ſeen, and been maſter of a teleſcope, made in the form of a walking-ſtaff, ſo that it was fitted to ſerve for ſeveral purpoſes, whereof though one was very different from the other, yet all of them were in the idea of the artificer, and intended by him. The like may be ſaid of a concave metalline burning-glaſs, which though it is employed to magnify the pictures of objects, to caſt their images into the air, and to concenter the ſun-beams to a focus, in which they will burn ſeveral bodies, yet theſe and many other things, which, though they ſeem to have little affinity with theſe, are performed by a metalline concave, were before-hand deſtinated by the artiſt, who foreſaw and intended, that in ſuch various junctures of circumſtances it ſhould produce all thoſe determinate effects.

And indeed, if we conſider God's omniſcience and providence, and how indulgent a Creator he has been to man, it may well ſeem reaſonable to think, that as God foreſaw, that men might make very various and profitable uſes of divers of his other creatures, by the help of that prerogative of reaſon, which he had vouchſafed them; ſo he deſigned, that men ſhould reap the advantages he had made many of his other works capable of affording them. And I confeſs, I think this reflection may juſtly ſerve to recommend the doctrine about Final Cauſes, that we embrace, to philoſophers, that are truly pious; ſince it furniſhes them with juſt arguments for gratitude to the Author of ſo many good things, as the corporeal world, by being contemplated or poſſeſſed, affords them. For to look upon the world, as vaſt and curious a work as it is, only as a vaſt and curious piece of workmanſhip, may indeed give a man a great idea of the power and ſkill of the divine Architect; but will rather exact his wonder than his gratitude: and therefore the antient Ariſtotelians, who looked upon the world as eternal and ſelf-exiſtent in a condition like its preſent ſyſtem, did not uſe to thank God for the benefits they received from things corporeal; though ſome of them thought themſelves obliged to thank nature, which they looked upon as acting with deſign, and propoſing to herſelf for ends, the welfare of the univerſe and of men. To illuſtrate this with ſomething, whoſe application is obvious: if a traveller being in ſome ill-inhabited Eaſtern country, ſhould come to a large and fair building, ſuch as one of the moſt ſtately of thoſe they call Caravanzeras, though he would eſteem and be delighted with the magnificence of the ſtructure, and the commodiouſneſs of the apartments, yet ſuppoſing it to have been erected but for the honour or the pleaſure of the founder, he would commend ſo ſtately a fabric, without thanking him for it: but if he were ſatisfied, that this commodious building was deſigned by the founder, as a receptacle for paſſengers, who were freely to have the uſe of the many conveniencies the apartments afforded, he would then think himſelf obliged, not only to praiſe the magnificence, but, with gratitude, to acknowledge the bounty, and the philanthropy of ſo munificent a benefactor.

SECT. IV.

IT remains now, that we diſcourſe a while of the fourth and laſt queſtion, propoſed at the beginning of this tract, which was, *With what cautions Final Cauſes are to be conſidered by the naturaliſt?*

But the caſes, whereto this queſtion may relate, are ſo many and ſo differing, that, what I ſhall endeavour upon ſo diffuſed and difficult a ſubject, will be rather to point you out ſome ſea-marks, that may direct you to ſhun thoſe latent rocks, againſt which divers learned men have daſhed, than to preſent you with a mariner's compaſs, and a ſea-card, that may conſtantly guide you in the courſes of your navigation, through ſo unfrequented a ſea.

And to make way for what I am to offer, by a diſtinction, the want of which ſeems to have contributed to the obſcurity of my ſubject, I ſhall obſerve to you, that there are two ways of reaſoning from the final cauſes of natural things, that ought not to be confounded. For ſometimes, from the uſes of things men draw arguments, that relate to the Author of nature, and the general ends he is ſuppoſed to have intended in things corporeal; as when from the manifeſt uſefulneſs of the eyes, and all its parts, to the function of ſeeing, men infer, that at the beginning of things the eye was framed by a very intelligent being, that had a particular care, that animals, eſpecially men, ſhould be furniſhed with the fitteſt organ of ſo neceſſary a ſenſe as that of ſight: and ſometimes alſo, upon the ſuppoſed ends of things men ground arguments, both affirmative and negative, about the peculiar nature of the things themſelves; and conclude, that this affection of a natural body or part ought to be granted, or that to be denied, becauſe by this, and not by that, or by this more than by that, the end, deſigned by nature, may be beſt and moſt conveniently attained. This latter ſort of arguments I am wont to call purely or ſimply phyſical ones; and thoſe of the former ſort may, for diſtinction's ſake, be ſtiled *phyſico-theological* ones; or, (if we will, with *Verulamius*, refer final cauſes to the metaphyſics) by a ſomewhat ſhorter name, metaphyſical ones.

What has been premiſed about theſe two ways of arguing, allows me to proceed to what I ſhall venture, though not without much diffidence, to offer you, concerning our grand queſtion, about which I ſhall refer my preſent thoughts to the five enſuing propoſitions.

Proposition I.

AS to the generality of cœleſtial bodies, it ſeems not ſafe to propound arguments of their nature, from the ſuppoſition of particular ends, at leaſt of the human ones, deſigned by the author of nature in framing them.

I will not only allow you, but encourage you, to take a riſe from the contemplation of the cœleſtial part of the world, and the ſhining globes that adorn it, and eſpecially the ſun and moon, to admire the ſtupendous power and wiſdom of him, that was able to frame ſuch immenſe bodies, and, notwithſtanding their vaſt bulk, and (if the earth ſtand ſtill) ſcarce conceiveable rapidity, keep them for ſo many ages, ſo conſtant, both to the lines and paces of their motion, without juſtling or interfering with one another. And I ſhall moſt willingly join with you, in returning thanks and praiſes to the divine providence and goodneſs, for having ſo placed the ſun and moon, and determined the former (or the earth) to move in ſuch lines, under that oblique circle aſtronomers call the ecliptick, that there needs ſkill in coſmography to be able to apprehend, how uſeful theſe ſituations and motions are for the good of men and other animals; and how diſadvantageous it would have been to the inhabitants of the earth, if the luminaries had been otherwiſe placed or moved than they are. But for all this, I dare not imitate their boldneſs, that not only affirm, that the ſun and moon, and all the ſtars, and other cœleſtial bodies, were made ſolely for the uſe of man; but preſume to ground arguments, to evince ſuch a ſyſtem of the world to be true, and ſuch another erroneous, becauſe the former is, as they think, better fitted to the conveniency of mankind, or the other leſs ſuited to that end, or perhaps altogether uſeleſs or unneceſſary to it: as when they argue, that the ſun and other vaſt globes of light ought to be in perpetual motion to ſhine upon the earth; becauſe, as they fancy, it is more convenient for man, that thoſe diſtant bodies, than that the earth, which is his habitation, ſhould be kept in motion. But, conſidering things as meer naturaliſts, it ſeems not very likely, that a moſt wiſe agent ſhould have made ſuch vaſt bodies, as the ſun and fixt ſtars, eſpecially if we ſuppoſe them to move with that inconceivable rapidity, that vulgar aſtronomers do and muſt aſſign them, only or chiefly to illuminate a little globe, that, without hyperbole, is but a phyſical point, in compariſon of the immenſe ſpaces compriſed under the name of heaven; whoſe lights might as well illuminate the earth, if they were a thouſand times leſſer than they are, provided they were placed at a proportionably leſs diſtance from it. And it will be very hard to aſſign, what conſiderable uſe the terreſtrial globe or its inhabitants derive from that multitude of cœleſtial globes, that make the milky way; ſince each of thoſe ſtars is ſo far from being ſingly able to enlighten the earth, that *Ariſtotle*, and the generality of philoſophers for many ages, (therein followed by divers of the Peripatetick ſchools at this day) took the whole aggregate of them for a meteor. And what light, or other known advantage, can the earth or its inhabitants derive from thoſe many fixt ſtars, that the teleſcope only can diſcover, (and which for that reaſon I ſometimes call teleſcopical ſtars) among the ſix or ſeven conſpicuous ones of the *Pleiades*, or among thoſe, that the naked eye can ſee in the belt or girdle of orion? which (conſtellations) I ſcarce ever look upon, through a good teleſcope, without wonder.

I know well, it may be ſaid, that theſe and other the like cœleſtial bodies may be at leaſt thus far uſeful to man, as to diſcover to him, and give him a riſe to admire and praiſe the greatneſs and power of the divine maker: and if this be ſaid, I ſhall not quarrel with the allegation, but readily grant, that though perhaps his wiſdom ſhines as bright to us men, in the ſtructure of a glow-worm, as in the diſpoſition of the unſeen ſtars, that make up the galaxy; yet the immenſity of his power could not perhaps be ſo well declared by leſs vaſt productions of it. But ſtill theſe arguments are not purely phyſical, but of that ſort, that I call phyſico-theological, whoſe inferences relate to the general intendments of God in the univerſe, which I therefore ſtyle coſmical ends, but do not reach to prove any thing about the determinate nature of particular bodies. And ſince the utmoſt, that philoſophy teaches us, is, that in general the good of man was one of the ends deſigned by God, in ſo framing the world as we ſee it is framed; there may be other ends deſigned by the ſame omniſcient author of nature, of thoſe teleſcopical and other ſmall or remote ſtars, whoſe uſes to us are doubtful or inconſiderable; towards the attainment of which ends, thoſe cœleſtial bodies and motions may be admirably contrived and directed. And we not being able by meer reaſon to inveſtigate what thoſe ends are, though we have not near ſo much reaſon to aſſure us, that there may not be ſuch ends, as the infiniteneſs of God's wiſdom gives us to think there may be; it is preſumptuous for us to judge of the ſyſtem of the world, and of the deſtinations of fixt ſtars ſo remote, that, though they be probably like ſo many ſuns, we cannot ſo much as diſcern them without good teleſcopes, by that ſyſtem's greater or leſſer advantageouſneſs to us: eſpecially ſince, though it were certain, that, among other uſes, God intended they ſhould be in ſome ſort ſerviceable to us, yet he has no way declared to us in what capacity, or to what degree, they ſhall be uſeful to us. And therefore if they be ſo in any meaſure (as for example mentally) they are ſo, for what we know, as much as he deſigned they ſhould be; and that itſelf being an unmerited favour, deſerves our humble thanks. And it ſeems very likely, that God did not deſign to all the parts of the earth itſelf, equal, and conſequently not the greateſt, advantages by the preſent ſyſtem of the univerſe; ſince the countries inhabited by the *Samoids* and *Novazemblans*, and other nations, that live very near the arctick pole, want many conveniences and advantages enjoyed by the inhabitants of the temperate zones, that lye nearer the way, in which the ſun moves.

But though bare philoſophy does not favour the bold opinion I dare not aſſent to, yet I know it will be pretended, that revelation does. And I readily confeſs, that the terraqueous globe, and its productions, (among which perhaps the atmoſphere may be reckoned) and eſpecially the plants and animals it is furniſhed with, do by the ſcripture appear to have been deſigned for the uſe and benefit of man, who has therefore a right to employ as many of them, as he is able to ſubdue: and that the two luminaries themſelves, Pſal. civ. 19. the ſun and moon, were appointed by God to give light upon the earth, and be uſeful to all the nations, that inhabit it: and that therefore the kingly prophet had reaſon to exclaim, Pſal. civ. 24. *How manifold are thy works, O Lord! how wiſely haſt thou made them all!* when in the precedent and ſubſequent words, he applies this to the terraqueous globe, and its inhabitants. And he might juſtly ſay, as Pſal. xix. 1. he elſewhere did, *that the heavens declare the glory of God, and the firmament ſheweth his handy work.* But theſe general declarations, though they be juſt motives of our wonder and thankfulneſs, yet I fear they are not good topicks to draw ſuch phyſical concluſions from, in particular caſes, as ſome learned men adventure to do. For I do not remember, that it is any where declared in the ſcripture, that the ſervice of man was the only, or perhaps ſo much as the chief, uſe of all the cœleſtial lights, and other bodies of that immenſe part of the world. And this ſingle conſideration ought to oblige us, to be very wary in making aſcriptions to ourſelves, as if the great ſyſtem of the world were to be eſtimated by our conveniences. And if it be ſaid, that things merely corporeal have not, and man alone has, a rational faculty, whereby to refer the great and wonderful works of God to the glory or their maker; I ſhall take the liberty to anſwer, that, though this has been affirmed by many, if not alſo aſſented to by all, yet I have not found it proved by any. And I ſomewhat wonder, that divines ſhould on this occaſion overlook that paſſage in the 28th. chapter of *Job*, which they generally interpret of the angels: for the queſtion, which God there puts to *Job*, may be juſtly applied to *Adam* Job. xxxviii. 4, 5, 7. himſelf; *where waſt thou, when I laid the foundations of the earth? declare if thou haſt underſtanding. When the morning ſtars ſang together, and all the ſons of God ſhouted for joy.* And indeed, if we even may preſume to conjecture of ſuch things, it ſeems to me reaſonable to think, that God created the angels before the material world, that he might have intelligent beings to pay him the juſt tribute of praiſes, for ſo admirable a ſpectacle as that of the riſing world, or rather the beginning and progreſs of the creation. However, by the words laſt cited out of the book of *Job*, it appears, that before man was made (for that he was not till the 6th. day) God wanted not intelligent ſpectators and applauders of his corporeal works. And ſince the angels are a nobler order of intellectual creatures than men, and are not unconcerned ſpectators of the works of God; how do we know, but that in the ſyſtem of that part of heaven, of which we need teleſcopes to know, that there is ſuch a thing in *rerum natura*; and in the plants, animals, or other furniture, whatever it be, of thoſe particular, and to our naked eyes inviſible, ſtars, that ſerve us men barely for declarations of their maker's power; ſuch intelligent ſpirits as angels may diſcern as wiſe deſtinations, and as admirable contrivances, as thoſe, which, at the forming of the earth and its furniture, invited their devout hymns and acclamations? and in this caſe, God will not loſe any thing of the glory due to the divine attributes diſplayed in the fabrick of the cœleſtial part of the world, though the fixt ſtars ſhould be neither only nor principally deſigned for the ſervice of men.

To what has been hitherto ſaid, to let you ſee the reaſonableneſs of my firſt caution, which repreſents the making particular and meerly phyſical inferences from the ſuppoſed deſtinations of cœleſtial bodies, as a thing unſafe, I ſhall now add in the ſecond place;

THAT it is yet more unſafe to ground arguments of the nature of particular bodies, that are inanimate in the ſublunary world, upon the uſes we think they were deſigned for.

THIS will not appear an unreaſonable caution, if we conſider, how little we know of the particular purpoſes of nature in thoſe bodies here below, which not being organical, like thoſe of animals and plants, cannot by the curiouſneſs of their ſtructure diſcloſe to us the particular ends, to which they were ordained. And as for their motions, ſince they are extremely far from being ſo conſtant and regular as thoſe of the cœleſtial bodies, the caution we gave about drawing arguments from the ſyſtem of the heavens, will not, ſure, be thought unfit to take place, when we ſpeak of clays, chalks, and ſtones, and the like terreſtrial bodies, whoſe textures are, comparatively to thoſe of living creatures, very ſimple, and ſlight, and ſeldom more curious, than may be made by art, by See the Tract of the Origin and Virtues of Gems. diſſolving ſtones and metals in chymical menſtruums, and afterwards chryſtallizing the ſolutions; of which I elſewhere give examples. It is true, that, though revelation ſpeaks rather of God's having deſtinated animals and vegetables, than inanimate bodies, to the ſervice of men; yet there is no abſurdity to conceive, that, generally ſpeaking, that may be one of the ends deſigned by the author of nature, in making metals, ſtones, and thoſe other inanimate parts of the terreſtrial globe, that man is able to maſter and make uſe of. But whereas in this globe the ſurface is diſtant from the center above three thouſand and five hundred miles; and I do not find, that either men's ſpades or their plumming lines have reached above one mile of that great number; nor is it very likely, that human induſtry will ever make its way down to the thouſandth part of that vaſt depth: it ſeems very improbable, that the remaining internal part of the earth, that is above ſeven thouſand miles thick, and may, for aught we know, contain great varieties of foſſils and other creatures, ſhould be made chiefly or only for the ſervice of men, from whoſe ſight they lie hid in a deeper well than that of *Democritus*, and who do not ſo much as know, what kind of bodies they are. And though it will not hence follow, that the terraqueous globe was made by chance, no more than that any of the other planets was ſo; becauſe the admirable ſtructure of plants and animals evinces the exiſtence and providence of a moſt wiſe and powerful author of things, who may juſtly be ſuppoſed to have made nothing in vain, even among the inanimate portions of our globe, whoſe animated portions are ſo wiſely and exquiſitely framed: yet, that thoſe inanimate bodies were made for determinate ends, is more eaſy to be deduced from the knowledge we have by other mediums, that they are the productions of a wiſe and provident author, than by the contemplation of theſe inanimate bodies themſelves. And perhaps it may be worth inquiry, whether ſome things may not be made, even by a wiſe agent, not out of a primary intention, but as productions, that will naturally follow upon the eſtabliſhment and preſervation of thoſe grand laws and rules of motion, that were moſt fit to be ſettled among things corporeal. And it is very poſſible, that, according to that coſmical eſtabiſhment (if I may ſo call it,) many parts of the terreſtrial globe ſhould be ſo placed or diſpoſed of, as not to be ſerviceable to men; becauſe the whole aggregate, or globulous maſs, could not otherwiſe be ſo well ſuited to the general deſtinations of the univerſe, which, if otherwiſe contrived, would perhaps have been leſs ſerviceable than now it is to man himſelf. To countenance which conſideration, I ſhall obſerve, that, though the eclipſes of the ſun and moon be uſually unwelcome, and, if aſtrologers may be credited, often very prejudicial to multitudes of men; yet the great *former of all things*, or, as the original will bear it, *of the whole*, did not think fit to alter the tracts or lines of motion, that he aſſigned the luminaries, to avoid the eclipſes, that muſt yearly enſue upon their moving in ſuch lines. Whence we may alſo learn, that ſome phænomena may not belong to the primary intention of nature, but are only the neceſſary conſequences and effects of the primitive conſtitution of the world, and the catholick laws of motion. And if it be here demanded, what the ends are, for which the deep and hidden parts of the terraqueous globe, and the teleſcopical ſtars of the firmament, were made, if they were not made for the uſe of man, I ſhall frankly anſwer, that I cannot tell: and I know not, but ſuch an anſwer may be more expreſſive of the profound reverence we owe the great author of nature, than their opinion is, that would have all theſe made for the uſe of man; ſince to ſay, that we know not, why ſome part of a work is made by an artiſt, whom other parts proclaim to be moſt wiſe and ſkilful, does both acknowledge our own ignorance, and leave it highly probable, that ſuch pieces of work are ſuited to purpoſes worthy of him and ſuitable to them; and ſeems therefore a ſafer and more reſpectful opinion, than to ſuppoſe him to have made ſuch things for a particular end, which we cannot make out to be in any conſiderable meaſure worthy of his wiſdom, and attainable by them.

Jotzer hac-col
Jer. x. 16.

Proposition II.

IN the bodies of animals it is oftentimes allowable for a naturaliſt, from the manifeſt and appoſite uſes of the parts, to collect ſome of the particular ends, to which nature deſtinated them. And in ſome caſes we may, from the known natures, as well as from the ſtructure, of the parts, ground probable conjectures (both affirmative and negative) about the particular offices of the parts.

To obviate miſtakes, you may pleaſe to take notice, both that in this propoſition I ſpeak only of thoſe ends and uſes of the parts of an animal, that relate to the welfare and propagation of the animal itſelf, and which therefore I formerly called animals ends; and yet that I do not thereby deny any declaration, that is made in the holy ſcriptures, that God deſigned, that the entire animals, as well as their parts, ſhould be in ſeveral ways ſerviceable to man. And having premiſed this to explain my meaning in the propoſition, I ſhall now conſider diſtinctly the two parts, whereof it conſiſts.

And 1. There is no part of nature known to us, wherein the conſideration of final cauſes may ſo juſtly take place, as in the ſtructure of the bodies of animals. And I confeſs, that when I aſſiſt at a well-adminiſtered anatomy, I do ſo wonder at the admirable contrivance of a human body, that I cannot but ſomewhat wonder, that there ſhould be found among philoſophers men, that can aſcribe it to blind chance. The Stoick, that in *Cicero* aſked an Epicurean, why chance did not make palaces and other buildings, ſeems not to me to have made an impertinent queſtion. For the commodiouſeſt houſes men's bodies dwell in, are far leſs curious ſtructures, than the manſions their ſouls reſide in: which you will not think a groundleſs paradox, if you conſider, that, whereas even in a palace, the materials being wood, ſtone, brick, mortar, glaſs, and four or five metals, are but few in compariſon of the parts of differing textures, as bones, nerves, ligaments, membranes, muſcles, veins, arteries, griſtles, glandules, jellies, humours, *&c.*; and their diſpoſition is exceeding ſlight, in compariſon of the curious and elaborate contrivance of the numerous parts, both ſolid and fluid, of the human body; whereof though the ſtable parts alone have been reckoned to amount to ſome hundreds, yet in every one of theſe parts, the bulk, figure, conſiſtence, texture, ſituation, connexion and aptneſs for motion, is the moſt commodious, that can be deviſed; and all of them are wonderfully ſymmetrical, both to one another and the whole body; to divers of whoſe motions, as leaping, running, ſpeaking, ſwimming, ſneezing, *&c.* a great number of them conſpire. And this number of parts is ſo artificially contrived and packed together, that though in a body, where no room is loſt, many parts do at the ſame time exerciſe very differing motions, each of them moves freely, and does not at all hinder another, but rather they promote each other's motions.

I WILL not ſuffer indignation to tranſport me ſo far as to wiſh, that thoſe, that deny the uſefulneſs of all the parts of their bodies, may fall ſick, or receive ſome wound, to be thereby at once convinced and puniſhed: but I will venture to ſay, that diſeaſes or hurts alone may ſhew, how excellently all the parts of our bodies are contrived in order to our welfare. For if ſo much as a finger be made bigger by tumors, or diſplaced by being put out of joint, or kept in a wrong poſture by contradictions, or have its continuity violated by cutting, or its tone changed by ſtrains or contuſions, or its ſenſe or motion taken away by the palſey, or its membranes fretted by ſharp humours, or its motions diſordered by the cramp or convulſions; in any of theſe caſes we quickly find, how commodiouſly the parts affected were framed or diſpoſed, when any diſeaſe or hurt gives them a præternatural conſtitution; that is, changes that figure, connexion, tone, *&c.* which, according to the inſtitution of nature, whilſt the body is in full health, does belong to it.

THE eye (to ſingle out again that part for an inſtance) is ſo little fitted for almoſt any other uſe in the body, and is ſo exquiſitely adapted for the uſe of ſeeing, and that uſe is ſo neceſſary for the welfare of the animal, that it may well be doubted, whether any conſidering man can really think, that it was not deſtinated to that uſe. The ſix or ſeven muſcles, that move the whole bulbe of the eye, upwards, downwards, to the right hand, to the left, and to various oblique poſitions; and the ſeveral coats and humours, that make up the ſenſory, have not only their bigneſs, ſhape, conſiſtence, ſituation and connexion, admirably adapted to that end; but the tranſparency of the cornea and the humours, the opacity of the uvea, and the ſemi-opacity of the retina, and the ſeveral motions of the parts of the eye, being requiſite to receive, tranſmit, refract, and diſpoſe the viſive beams, that come from the object, after the manner requiſite to make the livelieſt picture of it in the bottom of the eye, do no leſs concur to compleat this matchleſs organ of viſion: which is ſo rarely contrived in order to that uſe, and comparatively ſo little to any other, that there is no more raſhneſs to ſay, that an eye, than that a teleſcope, was made for an inſtrument to ſee with; that is, to diſcover the colours, magnitudes, ſhapes and motions of diſtant objects. And in that admirable perforation of the uvea, which we call the pupil, nature has much outdone art; for whereas we are fain to apply to the object-glaſſes of teleſcopes opacous bodies with ſeveral circular apertures, that ſome may let in leſs light, and others more, according as the objects are more or leſs bright or inlightened; that part of the uvea, that hangs in the aqueous humour, is an aperture, as the artiſts call it, that narrows and opens itſelf in a trice, according to the exigency of the objects we look on; which if they be ſo conſtituted or placed, that they reflect but a dim light, the curtain is preſently drawn open, and the pupil circularly widened, to let in the more beams of light; and the contrary happens, as often as the object, being too luminous or illuſtrated, would offend the organ, or diſturb the ſight, if the contraction of the pupil did not ſhut out ſome of its beams. But for the uſes of the ſeveral parts of the eye, I ſhall refer you to the induſtrious Jeſuit *Scheiner*'s *Oculus*, and *Des Cartes*'s excellent Dioptrics; where you will eaſily perceive, that, in framing the eye, nature did not only act with deſign, but with ſo much ſkill in optics, that a more than ordinary inſight into that ſcience, is neceſſary to underſtand the wiſdom of the contrivances; and perhaps no degree of ſkill in it would enable a man to alter them for the better. It were tedious to mention the other parts of the body, that manifeſtly appear to have been pre-ordained to certain uſes. The books of anatomiſts are full of paſſages applicable to this purpoſe; of which I ſhall ſay in general, that though what they deliver ſuffices to ſhew, that all the parts of the body are the effects of an intelligent cauſe; yet, unleſs their deſcriptions and reflexions be improved by men verſed in mathematics and mechanics, and, I ſhall venture to add, in chymiſtry too, we ſhall but imperfectly underſtand, how intelligent that cauſe is, or how much wiſdom it has diſplayed, in the ſtructure of a human body, and each of its parts.

I KNOW it is objected by the Epicureans, that the parts of animals were firſt made, and their uſes afterwards found out by men's ſagacity. But this is a ſophiſtical objection. For, firſt, as to many of the inner parts, as the heart, liver, ſpleen, kidneys, *&c.* they perform their functions without ſo much as our knowledge of their ſtructure, or perhaps their ſituation; ſo far are they from being applied to ſuch uſes by our ſagacity. And as for the limbs and other parts, which we can move at pleaſure, it is true, that they cannot be actually employed to the reſpective uſes, till they be actually formed; but that hinders not, but that in their formation they were therefore ſo formed, that they may be in due time fit for ſuch uſes. And therefore we ſee, that the chick is furniſhed with compleat eyes, and with wings and feathers, before he be hatched; though, whilſt he is yet incloſed in the egg, he cannot make uſe of them to ſee or fly. And why was it, do the Epicureans think, that nature provided a whole ſet of temporary parts for pregnant females, and animals in the womb, which, when

Illud in his rebus vitium vehementer ineſſe effugere, illorumque errorem præmeditemur, lumina qui faciunt oculorum clara creata proſpicere ut poſſimus, Lucret. de Nat. l. iv. Nihil ideo quoniam natum eſt in corpore ut uti poſſimus, ſed quod natum eſt, id procreat uſum. ibid.

when they are come into a freer ſtate, partly fall away of themſelves, and partly turn to a ligament, fitted no longer for the former, but for a more ſeaſonable uſe? And it is to be noted, that the production of theſe umbilical veſſels, and the placenta or analogous body in the womb, to which they are faſtened, is of no neceſſity nor uſe to the female before conception; and thereby thoſe temporary parts appear to have been deſigned by nature, not ſo much for the perſonal preſervation of the female as for the propagation of the ſpecies: which deſtination not coming to be accompliſhed, till a woman, for inſtance, has attained to a competent age, appears to have been pre-ordained by the author of mankind for the continuation of it.

And though it be true, that the ſagacity of men may have found out ſome uſes of ſome parts of their bodies, that cannot be made appear to have been primarily intended by the author of nature; yet that is no good argument, that thoſe uſes were not intended, which either are made within us, or do, as it were, obtrude themſelves upon us. And as for other uſes, the preſcience and goodneſs of God are ſuch, that it ought not to appear incredible, that he, that gave man both the limbs of his body, and the rational endowments of his mind, and that has made many parts, as the eyes and the ears, double, that one may ſupply the want of the other; did both foreſee what uſes men might, according to their ſagacities and emergencies, make of theſe parts, and ſo contrive the parts, that they ſhould be applicable to ſuch uſes. Suppoſe a wiſe man ſhould ſend his ſon to travel, and among other things give him a pocket-dial with a magnetic needle; and this traveller having loſt his way in ſome wild plain, or being at ſea in a veſſel, whoſe compaſs was broken or ſpoiled by a ſtorm, or ſome other miſchance: if, I ſay, in this caſe, though the traveller ordinarily employed his dial only to find the hour of the day, he ſhall now employ it to guide his courſe or ſteer the veſſel, by the help of the needles pointing northward; though this would be an effect of his own ſagacity, yet his father, being a wiſe and experienced man, may reaſonably enough be ſuppoſed to have foreſeen, that his ſon might have need of knowing the northern and ſouthern points of the horizon; and accordingly may have given him a dial furniſhed with a magnetic needle, rather than an ordinary gnomical dial. And ſo a man, that has taught another to paint landſkips, when he gives him a pencil and a pallet furniſhed with colours, to draw a particular proſpect, is not to be ſuppoſed to have deſigned, that he ſhould not employ them to any other purpoſe, if urgent circumſtances made it requiſite for him to do ſo.

Having inſiſted longer than I intended upon the former part of my propoſition, I now proceed to the latter; namely, that in ſome caſes we may from the known ends of nature, as well as from the ſtructure of the parts, ground probable conjectures, both affirmative and negative, about the particular offices of the parts: which I could not ſeaſonably do before, becauſe the arguments, that were founded on the uſes of the parts of animals, ſuppoſe not only, that thoſe parts were deſtinated to particular uſes knowable by us, but that the ſeveral parts of the body were contrived as wiſely and commodiouſly, as men are able to deviſe, in order to the ends of nature; which is always to be underſtood to have united in her deſigns the uſes of the parts, and the welfare of the whole.

And indeed if we conſider, how admirable a fitneſs there is in the parts of the human body, for inſtance, to thoſe particular ends we can diſcover them to have been predeſigned for; it ſeems allowable to conjecture, that ſuch a part was not primarily deſigned to ſuch an uſe, becauſe it is, on the account of its ſtructure or otherwiſe, leſs fitted for it, than the conſtant wiſdom of nature ſeems to require; eſpecially if there be any other parts, by which that office may be more commodiouſly performed. And on the other ſide it may be a probable ground, though not altogether ſo probable as the former, to conclude, that ſuch a part was deſtinated to ſuch an uſe, if the uſe itſelf appear to be neceſſary, and the part better fitted for it than any other is.

Thus, though anatomical and optical writers, as well as the ſchools, did for many ages unanimouſly conclude the cryſtalline humour to be the principal ſeat of viſion; yet the induſtrious *Scheiner*, in his uſeful tract, intituled *Oculus*, does juſtly enough reject that received opinion, by ſhewing, that it ſuits not with the ſkill and providence of nature, to make that part the ſeat (or chief organ) of viſion, for which it wants divers requiſite qualifications, eſpecially moſt of theſe being to be found in the retina. And I remember, that when I aſked our famous *Harvey*, in the only diſcourſe I had with him, (which was but a while before he died) what were the things, that induced him to think of a circulation of the blood? he anſwered me, that when he took notice, that the valves in in the veins of ſo many parts of the body were ſo placed, that they gave free paſſage to the blood towards the heart, but oppoſed the paſſage of the venal blood the contrary way; he was invited to imagine, that ſo provident a cauſe as nature had not ſo placed ſo many valves without deſign; and no deſign ſeemed more probable, than that ſince the blood could not well, becauſe of the interpoſing valves, be ſent by the veins to the limbs, it ſhould be ſent through the arteries, and return through the veins, whoſe valves did not oppoſe its courſe that way.

Thus, whereas former anatomiſts and phyſicians generally believed the nutrition of the parts by the venal blood, the more recent writers are wont to teach, that the parts are nouriſhed by the blood in its paſſage through the arteries. Not that they think the blood, that runs through the veins, altogether unfit to irrigate the parts with that vital liquor; but that they judge the veins to be leſs fit than the arteries, into which the blood comes immediately from the left ventricle of the heart, agitated and ſpirituous, and with a briſk impulſe, which forces out the particles of the blood, at thoſe pores of the arteries, that they find congruous to their ſhape and ſize, and which anſwer to the ſeveral parts, that are to be nouriſhed by corpuſcles ſo qualified. It were not difficult, if it were neceſſary, to accumulate inſtances to the ſame purpoſes with thoſe already mentioned; there being nothing more frequent in the books of anatomiſts, and thoſe that treat of the phyſiological and pathological parts of phyſic, than to draw arguments, as well affirmative as negative, about the uſe of the parts of the body, from their fitneſs or unfitneſs, or their greater or leſſer fitneſs, to attain ſuch ends, as are ſuppoſed to have been deſigned by nature. And indeed theſe argumentations occur ſo frequently, that I think there is leſs need of my increaſing them, than of my proceeding to give you a caution about them, which I ſhall do in the following propoſition.

PROPOSITION III.

IT is rational, from the manifeſt fitneſs of ſome things to coſmical or animal ends or uſes, to infer, that they were framed or ordained in reference thereunto by an intelligent and deſigning agent.

DIVERS things have incidently been ſaid in this paper, eſpecially in the firſt ſection of it, and others may hereafter be occaſionally added, that may juſtly be employed againſt that part of the Epicurean hypotheſis, which aſcribes the origin of things to chance, and rejects the intereſt of a deity, and the deſigning of ends, in the production and management of natural things. But becauſe I obſerve, not without grief, that of late years too many, otherwiſe perhaps ingenious men, have with the innocent opinions of *Epicurus* embraced thoſe irreligious ones, wherein (as I was ſaying) the deity and providence are quite excluded from having any influence upon the motions of matter, all whoſe productions are referred to the caſual concourſe of atoms: for this reaſon, I ſay, I thought it a part of my duty, as well to the moſt wiſe author of things, as to their excellent contrivance and mutual ſubſerviency, to ſay ſomething, though but briefly, yet diſtinctly and expreſsly, to ſhew, that, at leaſt in the ſtructure and nature of animals, there are things, that argue a far higher and nobler principle, than is blind chance. But that I may do what I here intend, with as much brevity as I can, I will do little more than name ſome particulars, that I have not obſerved to be ſo uſually reflected on to the purpoſe, for which I mention them. And I ſhall confirm theſe conſiderations but with one inſtance, and that too taken from a ſort of parts, that are as little elaborate, and therefore ſeem to be as little fit for my purpoſe, as almoſt any in the human body.

I WILL not now inculcate what has been delivered, and may be farther ſaid, of that exquiſite ſtructure of the bodies of dead animals, that is diſcoverable by the knives of anatomiſts, (though I ſhall not ſcrupulouſly forbear to touch lightly on a few things of that kind, that are requiſite to my purpoſe;) my preſent deſign being to ſet down very briefly a few arguments, to ſtrengthen the propoſition lately delivered.

FIRST then, I obſerve, that there ſeems to have been care taken, that the body of an animal ſhould be furniſhed, not only with all things, that are ordinarily neceſſary and convenient, but with ſome ſuperabundant proviſion for caſualties. Thus, though a man may live very well, and propagate his kind, (as many do,) though he have but one eye; yet nature is wont to furniſh men with two eyes, that, if one be deſtroyed or diſeaſed, the other may ſuffice for viſion. And ſo, if one ear grow deaf, a man may be converſed with, by the help of the other, that remains ſound. In ſhort, nature has furniſhed men with double parts of the ſame kind, where that duplicity may be highly uſeful, and can be permitted without incongruity to the reſt of the body. And this is the more conſiderable, becauſe in other parts nature appears to huſband things ſo, as to ſhun doing things ſuperfluous: as within the ſkull, ſome veſſels, that would in other parts of the body have double coats like other arteries, are much thinner, almoſt like veins; the thickneſs of the ſkull being ordinarily a ſufficient fence to them from external injuries.

ANOTHER argument, that divers things, that nature does about animals, are done with deſign, may be taken from what anatomiſts obſerve of thoſe parts of the womb or the fœtus, that are to be found but at certain times, at which there is need of them, and not at others, when they would be uſeleſs. Thus, when a woman is with child, the vaſa umbilicalia are produced, to be channels either for the blood or alimental juice and ſpirits, that then ought to paſs between the womb and the fœtus; which is to be nouriſhed, either only or chiefly, by the liquors derived to it through thoſe veſſels, aſſiſted by the placenta, that ſupply to it the want of eating with the mouth, which the unborn infant either does not at all, or does but very imperfectly, employ to feed himſelf. And though as long as he continues impriſoned in the womb-ſtate, theſe temporary parts, (if I may ſo call them) continue with him; yet, as ſoon as he comes abroad into the world, theſe umbilical veſſels, particularly the two arteries and the vein, together with the membranes they are wrapt up in, and thoſe (commonly called the chorion and the amnios,) that involve the fœtus, are thrown off, as unneceſſary to the born infant's new ſtate; and, when it has quitted the womb, are expelled after it, whence they are called the after-birth; there remaining only that part of the umbilical veſſels, that lies within the child's abdomen, between the navel and the liver, where its uſe is conſiderable, though new; it ſerving no more to convey blood, or an alimental liquor, to and fro, but degenerating into a ligament.

To the ſame purpoſe with this contrivance, we may mention that other, wherein nature employs the foramen ovale, that gives paſſage to the blood from the right ventricle of the heart to the left; that the circulation of it may be maintained, though it cannot in the embryo, as it does in a born child, paſs through the veſſels of the lungs from one of the ventricles to the other. For this foramen ovale being but (if I may ſo call it) an expedient, that nature employs, as long as that, which is intended to be an infant, remains an embryo; this temporary conformation is obliterated, when the child, breathing the free air, is in a condition to make the blood circulate through the pulmonic veſſels, according to the primary intention of nature. From which and the like inſtances we may infer, that theſe temporary parts were framed by a fore-caſting, as well as deſigning, agent, who intended they ſhould ſerve for ſuch a turn, and then be laid aſide; it being utterly improbable, that an undeſigning agent ſhould ſo appoſitely and exquiſitely frame ſcaffolds for the future buildings, if he did not beforehand deſtinate both the one and the other to concur to the ſame ultimate effect.

ANOTHER argument for our preſent purpoſe may be drawn from the conſideration of thoſe things, that in animals are commonly called inſtincts; whereof ſome more directly regard the welfare of the individuals they belong to, others the propagation of their ſpecies, and ſome again reſpect them both. The writers of voyages, and thoſe, that profeſſedly deliver natural hiſtory, recount ſtrange, and ſcarce credible, inſtances of the inſtincts obſervable in certain animals. But we need not lay the ſtreſs of our argument upon dubious, or ſuſpected relations; ſince what I have met with in authors of good authority, or received from the mouths of travellers of good credit, may ſerve my preſent turn; eſpecially if it be allowed, (as I ſee not, why it may not be,) to take the word inſtinct in a latitude, ſo as to compriſe thoſe untaught ſhifts and methods, that are made uſe of by ſome animals, to ſhun or eſcape dangers, or to provide for their future neceſſities, or to catch their preys.

DIVERS ſtrange things are delivered, not only by poets, but by more credible writers, about the wonderful ſagacity and government of bees, in point not only of oeconomy, but of politics too. But though I ſhall not build any thing upon the authorities, that I myſelf ſuſpect, yet, having had the curioſity to keep for a good while in my cloſet a tranſparent hive, whence there was a free paſſage into a neighbouring garden; and having thereby had the opportunity to make frequent obſervations of the actions of theſe little animals, and particularly to ſee them at work about making their combs, and filling them with honey; I confeſs I diſcovered ſome things, that I did not believe before, and was induced to look upon them as very fit inſtances of creatures endowed with natural inſtincts and providence. For it were hard for a mathematician, in contriving ſo many cells, as they make in the area of one of their combs, to huſband ſo little ſpace more ſkilfully, than they are wont to do. And not only they carefully and ſeaſonably lay up their honey, to ſerve them all the winter, but curiouſly cloſe up the particular cells with covers of wax, that keep the included liquor from ſpilling, and from external injuries. I do not here mention the prognoſtication of weathers, that may be made in the morning by their keeping within their hives, or flying early abroad to furniſh themſelves with wax or honey, or by their unexpected return before a ſtorm unſeen by men; becauſe I ſuſpect, that theſe things may not be ſo much the effects of inſtincts, as of a tenderneſs and quickneſs of ſenſe, ſuch as may be ſeen in a good weather-glaſs, and found in divers wounded and crazy perſons, that are affected with ſuch beginnings of the changes of the air, as are not yet perceived by other men. But among the peculiarities to be obſerved in the conduct of bees, I cannot but take notice, that after a fight, I have not without ſome wonder, ſeen them take up the dead, that lay on the ground, and fly away with them to I know not what diſtance from their hive.

ANOTHER obvious inſtance of the inſtinct, that nature has given even to ſome deſpicable inſects, may be taken from ants, to whom *Solomon* ſends the ſluggard to ſchool, to learn the providence of making ſeaſonable proviſion for the future. For it is known, that theſe little creatures do in the ſummer hoard up grains of corn againſt the winter. And their ſagacity is the more conſiderable, if it be true, what divers learned perſons affirm, that they eat or bite off the germens of the grains of corn they lay up, leſt the moiſture of the earth expoſed to the rains ſhould make it ſprout. But whatever become of this tradition, theſe inſects do ſome other actions, reſembling ſagacity and induſtry, that are not ſo contemptible as their bulk, though I muſt not ſtay to mention them particularly in this place.

THE untaught ſkill of ſpiders, in weaving their curious webs, that are ſo fitly contrived both to catch their flying prey, and give them immediate notice of its being caught, is a thing, which, if it were not familiar, would be looked upon as admirable. And this ſkill is not, as ſome imagine, an effect of imitation of their parents: for if the eggs be taken away and incloſed in a glaſs, when they come to be hatched by the heat of the ſun, the little creature will immediately fall to ſpinning in the glaſs itſelf, as was related to me by an eminent mathematician, that made the experiment. And I ſaw the leſs reaſon to diſtruſt it, becauſe, having by an external heat hatched many eggs of ſilk-worms, in a place, where there had not been any of a long time before, nor probably ever till then, yet the worms produced by theſe eggs did in autumn, of their own accord, climb up to thoſe convenient places I had prepared for them, and there weave thoſe curious oval priſons, in which they encloſe themſelves, and which are unravelled into ſilk, of whoſe extreme fineneſs or ſlenderneſs I have elſewhere given an account.

Nor is the provident induſtry of animals confined to inſects, of whom the poet, (if his words be taken in a popular ſenſe,) truly ſaith:

Ingentes animos anguſto in pectore verſant:

Since it is to be found in divers of the greater animals, particularly in beavers; of whom though ſome things, that are recounted by authors and travellers, are but fabulous; yet what has been related to me by ſober and judicious perſons, that were either born or lived in *New-England*, where, theſe animals abounding, they had the opportunity to obſerve them, is ſufficient to confirm ſuch relations, as may give one juſt cauſe of wonder. For theſe credible perſons affirmed, that the beavers with their ſharp teeth (whoſe ſhape and ſtrength I have admired) cut pieces of wood ſo, as to make them fit for their purpoſe: that, by aſſociating their labours, they lay theſe together ſo, as to build themſelves ſtrong winter-houſes, in which there is ſometimes a kind of ſecond ſtory, for the inhabitants to retire to, when the water chances to overflow: that for theſe houſes they chuſe a very convenient ſituation, juſt by ſome river, or other water, that can furniſh them with fiſh: and that the overture or hole, that belongs to each of theſe houſes, is placed juſt by the water, that they may immediately flounce into it, and ſo ſave themſelves, when their houſes are attacked. And to facilitate their ſwimming away, and the catching of their prey in the waters, nature has furniſhed them, as I have obſerved with pleaſure in a live beaver, with two feet, not made like thoſe of dogs, or cats, or like their own two other feet, but furniſhed with broad membranes betwixt the toes, like the feet of geeſe, ducks, and other aquatic animals, that are to uſe them as oars, to thruſt away the water, and facilitate their motions upon it and in it.

It were eaſy to accumulate inſtances of the ſagacity and induſtry of animals, for their own preſervation; but it is more eaſy to find notable ones among thoſe actions, that concern the propagation of their ſpecies.

The various arts employed by animals of differing kinds about the materials, the conſtruction, and the ſituation of their neſts, is uſually remarkable, and ſometimes wonderful. Of this ſkill we have divers eminent inſtances, ſome of which I have been delighted to ſee, but have not time to recount. Yet one there is, whoſe oddneſs will not ſuffer me to pretermit it. For in a country, that abounds with apes and monkeys, that are very greedy of bird's-eggs, and oftentimes climb trees to come at them, there is a ſort of birds, whoſe eggs they peculiarly affect, that do, as it were, hang their neſts at or near the end of ſome long flexible branch or wand, that grows over the water; by which means their inſidious enemies, who do not ſwim, cannot come at them underneath; and by reaſon of the yielding of the flexible branch or twigs, whereto the neſt is faſtened, they are frighted from venturing to paſs on, for want of a firm ſupport.

The ſtructure of the neſts of waſps, which they often make under ground to ſecure them, I have obſerved to be very curious and artificial, eſpecially when the young ones are formed in the little cells, where they lie hid and ſheltered, till they are ready to fly away.

I might here multiply examples of this kind, but I think it fitter to proceed, by telling you, that the inſtincts, that nature has implanted in animals to preſerve themſelves, though they would ſeem admirable if they were leſs familiar, are much inferior to that providence, that ſhe has furniſhed animals with, for the propagation of their ſpecies.

There are divers notable things to be met with in the neſts of ſeveral birds, both as to their materials, their ſtructure, and the very ſituations of the places pitched upon to build them in. I have ſeen ſome neſts, eſpecially Indian ones, which would make a man wonder, how the birds, that built them, ſhould ſeek and find ſuch odd, and yet, all circumſtances conſidered, commodious materials to build with. Of which we have an eminent inſtance in the neſts of certain Eaſtern birds, whoſe names I remember not, that make their neſts of a white ſubſtance, (which has been preſented me by ſome of our Eaſt-India merchants,) that looks almoſt like icthyocolla, in the ſhops commonly called iſinglaſs, and is diſſoluble in liquors, and ſo very well taſted, that it makes the chief ſawce, that they uſe in the ſouthern parts of India at their feaſts. The ſtructure alſo of the neſts of divers birds, both as to their figure, their capacity ſuitable to the bulk of the builders, and the accommodations they are furniſhed with for warmth and ſoftneſs, may deſerve to be applauded by mathematicians themſelves; eſpecially if it be conſidered, that theſe little untaught architects had no tools to make their curious buildings with, ſave their beaks and their feet. And yet much more of providence and foreſight appears in the ſituation of the places, that ſome birds make choice of to build their neſts in: as may be obſerved, not only in the pendulous neſts of ſwallows, and the crafty hidden ones of ſome European birds, but very conſpicuouſly in the hanging and moveable neſts, that we lately mentioned to be ſo oddly placed by ſome birds, to ſecure their eggs from apes and monkeys; and by the ſituation of the well taſted neſts I was newly ſpeaking of, which are to be found only upon high and ſteep rocks, and are ſo faſtened to thoſe concave parts of them, that look downwards, and, for the moſt part, hang directly over the ſea, that there is no getting them without much trouble and danger, by the help of boats and poles: upon which account, as well as that of their deliciouſneſs, they are very dear in the *Eaſt-Indies* themſelves. The like care to contrive their neſts advantageouſly, and make them in ſecure places, is taken by divers inſects themſelves; as may be obſerved in the ſubterraneal neſts of the waſps formerly mentioned, and in the eggs of ſnails, which I have ſometimes found hid under ground, and had the curioſity to hatch in glaſſes furniſhed with the ſame earth they were found in.

If I ſhould here reckon up and diſplay the ſeveral effects, and conſequently arguments, of the wonderful providence, that the moſt wiſe author of nature exerciſes about the propagation of animals, by diſtinguiſhing them into male and female; by furniſhing both ſexes with mutual appetites and organs, exquiſitely adapted to the increaſe of their kind; by the admirable formation of the fœtus in the womb, without the female's knowledge, how it is performed; by the ſtrange ſubtilties and courage, that ſeveral of them, either oviparous or viviparous, have, to hide and defend their young; by the full proviſion, that is made for the nouriſhment of the fœtus, and the welfare of the female after ſhe has brought it forth; and by divers other ways, that I muſt not now ſtay to ſpecify: if, I ſay, I ſhould venture to do this, I might indeed much enrich and adorn my argument, but ſhould make this diſcourſe too much exceed the limits, that my deſign, and ſmall ſtock either of ability or leiſure, would allow. And therefore, inſtead of purſuing a ſpeculation, that would lead me a great deal too far, I ſhall look back upon the intimation I gave not long ſince, that even thoſe meaner parts of animals, which ſeem to have been framed with the leaſt care or contrivance, are yet not unworthy of their author.

For proof of which I ſhall now obſerve, that though the teeth be ſome of the leaſt elaborate parts of the human body; yet even theſe afford more obſervations appliable to our preſent purpoſe, than my intended brevity will permit me to take notice of. And therefore I ſhall only, and that little more than tranſiently, conſider a few of them here; and ſome of the others elſewhere, on thoſe particular occaſions, on which it will be more proper to bring them in.

I. And firſt, it is conſiderable, that whereas, when a man is come to his full ſtature, all the other bones of the body ceaſe to grow, the teeth continue to grow in length, during a man's whole life.

This growth of the teeth appears, not only by their continuing ſo many years of the ſame length, but by the unſightly length of one tooth, when that, which was oppoſite to it in the other jaw, happening to fall out or be pulled out, the tooth we ſpeak of has liberty to grow into the gap made by the removal of the other. Of this difference in point of growth betwixt the teeth and other bones, what reaſon can be ſo probably given, as, that it is deſigned to repair the waſte, that is daily made of the ſubſtance of the teeth, by the frequent attritions that are made, between the upper and lower tyre, in maſtication?

II. Whereas the other bones of the body (ſome few ſmall ones excepted) are inveſted with a very thin and ſenſible membrane, which, for its cloſe adheſion to the bone, is by anatomiſts called the *perioſteum*; that part of each tooth, which is not covered by the gums, has none of this membrane, which would be ſubject to frequent and very painful compreſſions and lacerations.

III. To enable the teeth to break, and make comminutions of the more ſolid kind of aliments, nature has providently framed them of a cloſer and harder ſubſtance, than almoſt any other bones of the whole body; though theſe be ſo numerous, that anatomiſts reckon above three hundred of them. And I have met with relations in authors of good credit, that ſome men's teeth have been ſo hard, as, when ſtruck with another fit body, to produce ſparks of fire.

IV. That theſe bones, whoſe uſe (to prepare aliments for nutrition) is ſo great, and almoſt neceſſary, may themſelves be continually fed and cheriſhed, though they grow in other bones, the all-wiſe author of things has admirably contrived an unſeen cavity in each ſide of the jaw-bone, in which greater channel are lodged an artery, a vein, and a nerve, which thorough leſſer cavities, or, as it were, gutters, ſend their twigs to each particular tooth; which, by theſe little veſſels, that reach to it, receives a continual ſupply of nouriſhment and ſtrength.

V. In regard, that babes are, according to nature's inſtitution, to feed for a conſiderable time on milk, for which there is no need of teeth, and which would alſo hurt the nipples of her, that gives them ſuck; nature forbears, for many months, to produce teeth in human infants: whereas the fœtus's of divers brute animals, that are oftentimes reduced early to ſeek out aliments, that are not fluid, nor very ſoft, are born with teeth already formed in their jaws.

The bony ſubſtance appointed for the comminution of aliments, ought not, for ſeveral reaſons, (which for brevity's ſake I here omit,) to be in either jaw entire, or all of one piece; and therefore nature has providently made for that uſe a competent number of diſtinct bones in either jaw. And becauſe men may often have occaſion to feed upon very differing ſorts of aliments, and uſually the ſame aliment may require differing preparations in the mouth to facilitate the digeſtion of it in the ſtomach; nature has provided men with two rows or ſets of teeth, equal for the moſt part in number, (each jaw in men uſually having ſixteen, and in women fourteen or fifteen,) and anſwering to each other, but yet of differing ſhapes, for differing uſes. For ſome, as the fore-teeth, are broader, and with a kind of edge, to cut the more yielding ſort of aliments; whence theſe teeth are called *inciſorii*. Others are ſtronger, and more fitly ſhaped to tear the more tough and reſiſting ſort of aliments: theſe are they, that by the vulgar are in Engliſh called eye-teeth, and which, for their reſemblance to thoſe of dogs, are by anatomiſts called *canini*. And then there is a third ſort, whoſe principal office is to grind the aliments, that are cut or torn by the others; and for this purpoſe they are made much broader, and ſomewhat flattiſh, but yet with their upper ſurfaces uneven and rugged, that by their knobs and little cavities they may the better retain, grind and commix the aliments, that are to be chewed by them; and for this reaſon they are called *molares*.

VII. AND becauſe the operations to be performed by the teeth oftentimes require a conſiderable firmneſs and ſtrength, partly in the teeth themſelves, and partly in the inſtruments, that move the jaw, wherein the lower ſet of them is fixed; nature has provided the lower jaw, (which alone is moveable, unleſs, as ſome affirm, in crocodiles,) with ſtrong muſcles, to make it bear forcibly againſt the upper jaw; and has not only placed each tooth in a diſtinct cavity of the jaw-bone, as it were in a cloſe, ſtrong, and deep ſocket, but has furniſhed the ſeveral ſorts of teeth with hold-faſts ſuitable to the ſtreſs, that, by reaſon of their differing offices, they are to be put to. And therefore, whereas the other teeth (the cutters and dog-teeth) have uſually but one root, (which in theſe laſt named are wont to be very long;) the grinders, that on many occaſions are employed to crack nuts, bones, or other hard bodies, before they can be ground, are furniſhed with three roots, and oftentimes with four, in the upper jaw, whoſe ſubſtance is ſomewhat ſofter, and whoſe grinders ſerve as ſo many anvils for thoſe of the lower to ſtrike or preſs againſt. On which account, as hath been already intimated, the lower jaw, (for the other belongs to the immoveable part of the ſkull,) is furniſhed with a ſtrong muſcle on either ſide, capable of moving it, and conſequently the teeth in it, with great force againſt the upper jaw.

IF ſome favourer of *Epicurus*'s doctrine ſhall here object, that, though man indeed be advantageouſly furniſhed with teeth, yet there are many other animals, and even quadrupedes, whereof ſome have not near ſo many teeth as man, nor ſo commodiouſly ſhaped and placed as his; and others are not furniſhed with any teeth at all: and that likewiſe there are many other animals, that have ſome of their other parts leſs convenient in their kind, or otherwiſe are not near ſo well provided for, as they would be, if they were not rather caſual productions, than thoſe of an intelligent and deſigning opificer: if theſe things, I ſay, be objected, I muſt own myſelf of a very differing opinion from the objector. And I think I could add much about the final cauſes of things corporeal, as the conſideration of them leads to a high veneration of their divine author, and as it tends to manifeſt, that, when his providence is denied or condemned, it is for want of its having been ſufficiently underſtood, and duly conſidered. But beſides, that this third propoſition ought to be but one part of our diſcourſe of final cauſes, I have in great part prevented myſelf already, by what I have formerly ſaid to obviate or anſwer ſome exceptions, relating to the eyes of man, and differing animals. For moſt of the conſiderations, if not all, that have been alledged on the occaſion of thoſe organs of ſight, may well be, *mutatis mutandis*, applied to the varieties, that are to be found in the teeth, and other parts, of differing kinds of animals. For I may juſtly repreſent, that the reaſon, why this or that organical part of this or that ſpecies of living creatures has not ſuch a ſtructure, or is not ſo placed, as we might think moſt convenient, may often be, that in this caſe it would be leſs proper for other ends, of more importance to the welfare of the animal, than ſuch a fabrick and ſituation of the part as we prefer, would be. And there are alſo many caſes, wherein the thing, that we make bold to think wanting or amiſs, is provided for by other contrivances in the ſame animal; by which proviſion the part under conſideration is made more ſerviceable and ſymmetrical to the reſt of the body; and ſo, performing other offices beſide the main, is, upon the whole matter, more uſeful to the animal, than otherwiſe it would be.

IT is known, that oxen and ſheep, and many other ruminating beaſts, are not furniſhed with near ſo many teeth as men are, and as are to be found in dogs, cats, horſes, and many other quadrupeds. But for the paucity of teeth amends is made in moſt of thoſe animals, partly by the power and inſtinct they have to chew the cud, and thereby make a ſecond attrition of their already much ſoftned aliments; and partly by the ſucceſſive cavities or ſtomachs, (diſtinguiſhed by the names of *primus venter*, *reticulum*, *omaſus* and *abomaſus*,) through which the aliment is tranſmitted, and more and more elaborated, to make it fit for further uſes. The mouths (eſpecially the inward parts of them) of the beaver, the tortoiſe, the bee, the humming bird, that feeds on flowers, whoſe exudations with his long little bill he ſucks like the bee: theſe, I ſay, and many other animals, (to omit the elephant himſelf,) have their mouth, and their ways of preparing their aliments for the ſtomach, very differing from what is obſerved in men, and yet very convenient for them reſpectively, all circumſtances conſidered.

THESE and the like, whether compenſations or expedients, are in many animals ſuch, that there is no cauſe to tax the author of nature, for not having given ſome animals all the ſame parts, that others are furniſhed with: but rather the thrifty providence, (if I may ſo ſpeak,) and deſigning wiſdom of God, in the contrivance of his viſible works, may be as well diſcovered by the ſeeming omiſſion of this or that part, that is uſeful to other animals, but is not neceſſary to thoſe, wherein it is not found, as by granting thoſe parts to the animals, to whoſe compleatneſs or welfare they are neceſſary, or highly conducive. On which account it is not to be thought ſtrange, that he has not to men, as to frogs, and many ſorts of birds, given ſuch tough, tranſparent, and moveable membranes, as theſe animals are provided of to cover their eyes from harms, that thoſe of men are not uſually expoſed to. And it is not an omiſſion, not to have given girls ſwelling breaſts, before they are capable of generation, more than it is, not to continue to them, after their being grown mothers, the *placenta uterina*, when they are not with child.

Though batts be looked upon as a contemptible ſort of creatures, yet I think they may afford us no contemptible argument to our preſent purpoſe. For in this heteroclite animal you may diſcern the fœcundity of the divine artificer's ſkill, which has in this formed an animal, that flies like birds, and yet is not only unfurniſhed with feathers, but is of a fabrick quite differing from that of other birds. And in this little animal we may alſo obſerve, both the compenſation, that is made for parts, that ſeem either deficient, or leſs advantaged than thoſe of the ſame denomination in other birds, and the regard, which the divine artiſt appears to have to the ſymmetry of parts, in his animated works, and to their fitneſs for the places they are to live in or frequent. For the batt being to act ſometimes like a bird, that flies freely to and fro in the air, and on ſome occaſions like a terreſtrial animal, ſuch as is that little quadruped a mouſe, ought to be furniſhed with parts ſuitable to ſuch differing deſtinations: and therefore, to fit him to anſwer the firſt of theſe, the want of feathers in the wings is ſupplied by a broad membranous expanſion, and a kind of toes furniſhed with articulations, that make up the wings: and becauſe this animal was to be able, like other birds, to forbear ſettling on the ground, otherwiſe than his occaſions required; each of his wings is furniſhed with a ſtrong crook, like the claw of a bird's foot, by the help of which he can faſten himſelf to trees, walls, and divers other erected bodies, and keep himſelf ſuſpended in the air, and continue at what diſtance he pleaſes from the ground. And becauſe he is furniſhed with teeth, which other birds want, to chew his food, and thereby prepare it for digeſtion; he needs not have a crop, or ſuch a ſtrong and muſcular ſtomach, as is uſually found in birds. And (in ſhort) to omit the peculiar ſtructure of other internal parts, wherein the batt differs from other birds; ſince the female was not, like them, to be oviparous, but, like mice and other quadrupeds, that bring forth their young ones alive, ſhe is not only furniſhed with an uterus fitted for that purpoſe, but in regard ſhe does not, like birds, that lay eggs, exclude, together with the fœtus, a competent ſtock of aliment to nouriſh it, till it can ſhift for itſelf, the batt is furniſhed with dugs, to give ſuck to her young ones: and by Zoographers it is obſerved, that, as ſhe has but two teats, ſo ſhe brings forth but two young ones at a birth; whereas mice are much more prolifick.

The writings of Zoographers, and the relations of travellers, afford divers other inſtances of the various, and yet excellent, contrivances, that are to be found in ſeveral animals, that differ from man, (who is an animal endowed with numerous teeth,) in the fabrick of the mouth, and other parts inſervient to the reception of aliments, and their preparation for digeſtion.

But paſſing by the mouths of tortoiſes, cameleons, and other animals, the hardneſs of whoſe gums, in reference to their ordinary aliments, ſuffices to make amends for their want of teeth; there is one *American* beaſt, which, I think, I ought not to forbear mentioning here, as a notable inſtance to manifeſt, how the wiſe architect can compenſate the want of teeth, by the rare ſtructure of the mouth and tongue, and their fitneſs to ſeize on and make uſe of thoſe aliments, which, though uncommon for a beaſt of his bulk, he ſeems to have been deſtinated to live upon. The animals of this kind are by *Hernandus*, who retains their American names, called achoas and tamendoas; and of theſe, and particularly of the parts they are provided of to eat with, he gives us this account. *Offenduntur apud Yucatenſes quadrupedes quidam, dorſo præduro & fulvi, agnorum magnitudine, ſed qui ventre circiter terram attingant, dentium omnino expertes ſint, & ſolo formicarum venatu vivant, quarum cumulos duobus magnis unguibus, quibus ſinguli anteriores pedes armantur, excavant turbantque; ac dein exerta lingua, quæ dotrante longior eſt, ſcabra, teres, ac pennam anſerinam craſſa, formicas eam conſcendentes ac denſantes ſuſcipiunt, eademque contracta, & in os, quod mirum in modum anguſtum ac parvum eſt, recepta, gratum ſibi pabulum capiunt, & innocentium animalium præda potiuntur.* Of the ſame ſort of beaſts, the ingenious *Piſo*, in his Hiſt. of Braſile, (where he practiſed phyſick) mentions two kinds, the greater and the leſs, which he, like *Hernandus*, calls tamanduas, but adds the new coined name of myrmechophaga; and of both gives this account. *Utræque* (ſays he) *ſunt noctambulæ pabuli cauſa; cicuratæ carne quoque veſcuntur, ſed minutim conciſa, quia non ſolum capite, promuſcide, ſed & ore ſunt anguſto, accuminato, edentuloque, lingua denique, inſtar craſſioris chordæ, tereti adeoque longa præſertim: in tamandua majori, ut duorum pedum longitudinem excedat, atque proinde duplicata (quod notatu ſane dignum) quaſi canali incumbit inter inferiores genas, quam eſuriens madidam exerit, & arborum truncis diu imponit,*

Vid. Schotti Phyſ. Curioſ. l. 8. c. 5.

Gulielmus Piſo l. 5. Hiſt. Nat. & Med. c. 22.

mox formicis opertam repente retrahit. Si alte fodiendo latebræ earum detegi poſtulant, unguibus id præſtat commode, quibus pedes poſteriores inſtructi ſunt ſatis validis & longis numero quinque, anteriores quatuor, iiſque recurvis duobus in medio maximis.

It is alſo to be conſidered, that divers things may be uſeful in an organical part, beſides that, whereby its function is primarily and mainly exerciſed: as, though the eye-lids and their motions, together with the little glandules, that belong to them (moſt of which lye concealed under the edges) are not at all neceſſary to the act of viſion, (no more than curtains are to a window;) yet they are to the compleatneſs and welfare of the eye, which is the neceſſary organ of viſion; as is manifeſted by the pain and prejudice the eye receives, if the eye lids, which are ſubject to more than one diſtemper, be conſiderably diſaffected.

I may hereafter have occaſion to take notice, that beſides thoſe uſes of the parts of a human body, which I venture to call anatomical, becauſe they are ſuch as anatomiſts have diſcovered by mere diſſections, there may be of ſeveral parts other uſes, which I call chymical, becauſe theſe parts do elaborate ſpirits of ſeveral ſorts, and perhaps exerciſe ſome other ſpagyrical functions of great importance, if not neceſſary to the welfare of a living man.

And, beſides the anatomical and chymical uſes, there may be others very fit to be conſidered in ſome parts of a human body; as the mechanical advantages, for which the various ſhapes and ſtructures of differing muſcles, and the ſeeming irregular, and, as it were, caſual fabric of the bones, and eſpecially of the proceſſes and protuberances, are admirably fitted. And there are alſo in ſome parts, as the eyes, optical reaſons to be conſidered, before one can otherwiſe than raſhly cenſure, what the Author of nature has done about them: as, though the figure of the chryſtalline humour be much more globous in moſt fiſhes, than in men and terreſtrial animals, yet he, that underſtands the doctrine of refractions, and conſiders that fiſhes, under water, are to ſee objects through a far thicker medium than air, will readily acknowledge, that this difference between the eyes of fiſhes and thoſe of men, is not an imperfection in the former; but, whilſt thoſe creatures are in their own element, a great advantage. And, to be ſhort, I think there are ſo many ſciences, and other parts of knowledge, ſome of them perhaps ſcarce yet diſcovered, that may be required to warrant a man, to cenſure the ends of God in the bodies of animals, that very few have knowledge enough to be capable of condemning them without raſhneſs: and they, that have knowledge enough to judge aright, will not be forward to condemn them, but admire them. But though this conſideration be not here diſplayed, yet the now mentioned intimation of it may afford us this reflection; that men may eaſily be too raſh, if they think a part bunglingly framed, upon ſuppoſition, that, by the anatomical inſpection of it, they know all the uſes, that the ſkill of the divine Opificer could deſign it for.

Nor will it neceſſarily follow, that becauſe in ſome particular bird, or beaſt, or fiſh, we may not be able to give an account, why this or that part is not to be found, or why it is otherwiſe framed or ſituated, than that, which is analogous to it in man, it muſt therefore be caſually or improvidently framed or placed; ſince we cannot expect, from brute animals, anſwers to thoſe proper queſtions about their own bodies, which we can receive from men about their human ones. And yet, notwithſtanding the great aſſiduity, with which the more curious phyſicians are obliged to cultivate anatomy, and the frequent opportunities they have to do it, and to aſk living men queſtions about what they find, when the natural uſe of their parts is hindred or perverted; our ſagacious moderns are, to this day, at a loſs, as to the true uſes of the viſible parts of the body; to ſay nothing of the inviſible, ſuch as ſpirits, ſalts, &c. So that it ought to be no wonder, if in animals, whoſe fabric we have much leſs concern to inquire into, and much leſs opportunity to examine, we ſometimes find parts, of whoſe uſes, and their fitneſs for them, men are not yet able to give a ſatisfactory account. For I conſider, that even in man himſelf, though there be numerous valves found in his veins, yet for thoſe many ages, that the true uſes of them lay hid, an *Aſclepiades*, or ſome other bold Epicurean phyſician, might have thought himſelf well-grounded to look upon them as ſuperfluous parts, which, now that the circulation of the blood is diſcovered, they are acknowledged to be far from being.

On this occaſion it may help us, if it be conſidered, that, ſince God is both a free and a moſt wiſe Agent, it need not ſeem ſtrange, that he ſhould adorn ſome animals with parts or qualities, that are not neceſſary to their welfare, but ſeem deſigned for their beauty: ſuch as are the diſpoſition of the cameleon to change colours; and the lovely greens, blues, yellows, and other vivid colours, that adorn ſome ſorts of pigeons, and of parrots, and divers leſſer birds, as goldfinches, canary birds, and eſpecially thoſe admirably little winged creatures humming-birds. And on the other ſide, ſometimes God's wiſdom ſeems to be, as it were, thrifty, and ſolicitous not to beſtow on an animal, or a part of it, more than is neceſſary for the uſe, for which it is deſigned. As the veins are by anatomiſts obſerved to have but one coat or membrane, and uſually to lye more expoſed, than the arteries, that accompany them; theſe have ſtronger and double coats, becauſe they are to convey a more important liquor, (the arterial blood) which, beſides that it is more agitated and ſpirituous, is forcibly impelled into thoſe veſſels by the muſcular contraction, or ſtrong impulſe of the heart. And to the ſame purpoſe it may be obſerved, that the arteries within the ſkull are far more thinly coated than elſewhere; the ſolidity of that bony part being a fence to the veſſels that it covers. And to add, that, on this occaſion, we may obſerve, that though the nerves uſually lye deep in the parts, to be kept both ſafe and warm, being very liable to be offended both by cold, and the contact of external bodies; yet, it being neceſſary that the optic nerve ſhould expand itſelf into the eye, the membranes that inveſt the nerve and other coats of the eye, (except the *retina*, which ſeems to conſiſt of the medullar fibres) are made, by great odds, more firm than the *dura* and the *pia mater*, whence they proceed; and though expoſed to the free air, are leſs ſenſible of the cold than moſt parts of the body, and will bear, without danger, divers liquors, and other offenſive things, whoſe pungency would put other nerves of the body into convulſive, and perhaps very dangerous motions. This (conduct) looks as if God, like an excellent writing-maſter, did, in the great volume of his creatures, intend to beſtow on ſome of theſe, things rather ornamental than neceſſary, as flouriſhes on the capital letters of the alphabet of nature; and ſometimes to employ characters, and divers of them very differingly ſhaped, (as the *Latin* are from thoſe of the *Greek*, the *Hebrew*, the *Saxon*, &c.) to expreſs the ſame letter; and ſometimes alſo to imply abbreviations, as a ſtroke or a daſh, inſtead of a letter or a ſyllable, to expreſs compendiouſly that, which might be very juſtifiable, had it been more fully ſet down or delineated.

IF that be admitted, which we have formerly propoſed as very likely, that God deſigned, by the great variety of his works, to diſplay to their intelligent conſiderers the fecundity (if I may ſo ſpeak) of his wiſdom; one may readily conceive, that a great part of the variety obſervable in the analogous parts of animals, as their eyes, their mouths, &c. may be very conducive to ſo reaching and comprehenſive a deſign; to which the beauty of ſome creatures and parts, as well as their more neceſſary or convenient ſtructure, may be ſubſervient; eſpecially if the innocent delight of man be alſo intended, as it may ſeem to be in the curious colours and ſhapes of divers flowers, and in the melodious muſic of ſinging birds, and in the vivid and curiouſly variegated colours of the feathers of ſeveral winged animals, particularly thoſe that make up the peacock's train.

WE are not near ſo competent judges of wiſdom, as we are of juſtice and veracity; for theſe laſt named are to be eſtimated by external and fixed bounds or rules, which are very intelligible to a moderate underſtanding: but as for wiſdom, the more profound it is, the leſs we are able to look through it, and penetrating to the bottom of that, to judge knowingly of its actions. And therefore, though we may ſafely conclude, that God acts wiſely, when he does ſomething that has an admirable tendency to thoſe ends we juſtly ſuppoſe him to have deſigned; yet we cannot ſafely conclude, in a negative way, that this or that is unwiſe, becauſe we cannot diſcern in it ſuch a tendency. For ſo wiſe an Agent may have other deſigns than we know of, and further aims than we can diſcern, or perhaps ſuſpect; and may have at hand, or furniſh himſelf with, ſuch means to compaſs his ends, and that even by the co-operation of thoſe means we think uſeleſs or improper, as far as above the reach of our conjectures, and without the knowledge of which we but raſhly cenſure the wiſdom of his proceedings

IN the double horizontal dial, formerly mentioned, it would be raſhly done of thoſe, who ſhould condemn or deſpiſe the various lines, they find traced upon that uſeful inſtrument, becauſe they ſee, that they are not neceſſary to ſhew the hour of the day; ſince the mathematician, that drew thoſe lines ſo curiouſly, may be well ſuppoſed to have more ends than one or two in making the inſtrument, and not to have drawn them by chance or unſkilfully, though the inconſiderate cenſurers do not know, for what other or further purpoſes the artiſt may have deſigned them.

SUPPOSE ſome Indian fiſherman, unacquainted with European arts and affairs, ſhould happen to come aboard a man of war under ſail; though he would quickly perceive by the uſe, that was made of the ropes, pully, &c. that this floating building was very artificially contrived; yet if he ſhould fix his eyes upon one of the guns, and the anchors, and perceive that no uſe was made, nor like to be made of them in ſailing, he would be ſtrongly tempted to think, that thoſe heavy maſſes were uſeleſs clogs and burdens to the veſſel: but if he were told the neceſſity and uſefulneſs of the guns for defence, and of the anchors to ſtay the ſhip in convenient places in ſtorms, he would eaſily alter his mind, and confeſs, that he blamed the builders and furniſhers of the ſhip, for that, which nothing but his ignorance kept him from highly commending.

I HAVE dwelt much longer than I intended on this third propoſition, becauſe I think it a duty our reaſon owes to its Author, to endeavour to vindicate his manifold wiſdom, in this libertine age; wherein too many men, that have more wit than philoſophy or piety, have upon Epicurean, and ſome alſo even upon Carteſian principles, laboured to depreciate the wiſdom of God, and ſome of them preſumed to cenſure the contrivances of theſe living *automata*, that (in their protoplaſts) were originally his. And it was not only the ſeaſonableneſs of ſaying, about ſo important a ſubject, ſome things, that poſſibly have not yet been met with, or at leaſt duly conſidered, that has made me thus prolix; but a deſire, that my reader ſhould not barely obſerve the wiſdom of God, but be, in ſome meaſure, affectively convinced of it. To which purpoſe, in my opinion, it is very conducive, if not neceſſary, beſides general notions, to obſerve, with attention, ſome particular inſtances of the divine ſkill, wherein it is conſpicuouſly diſplayed. It is true, that in the idea of a being infinitely perfect, boundleſs wiſdom is one of the attributes, that is included. But, for my part, I ſhall take leave to think, that this general and indefinite idea of the divine wiſdom, will not give us ſo great a wonder and veneration for it, as may be produced in our minds, by knowing and conſidering the admirable contrivance of the particular productions of that immenſe wiſdom, and their exquiſite fitneſs for thoſe ends and uſes, to which they appear to have been deſtinated.

Proposition IV.

That we be not over-haſty in concluding, nor too poſitive in aſſerting, that this or that muſt be, or is, the particular deſtinated uſe of ſuch a thing, or the motive, that induced the Author of nature to frame it thus.

IT has been above declared, that ſome parts are ſo excellently, and ſo manifeſtly fitted for a certain uſe, as the eye for ſeeing; and ſo much better fitted for that, than for any other; that it were little leſs than heedleſsneſs or perverſeneſs, to doubt of its being deſtinated thereto. But the like cannot be ſaid of all the other parts of the body, eſpecially of the internal. And there are divers uſes, either neceſſary, or highly conducive, to the welfare of the animal, to which no one part is ſo much more conſpicuouſly fitted than any other, but that it is more difficult than many think, to determine the true and primary uſes or offices of ſome parts, eſpecially with ſo much certainty, as thereon to ground phyſiological inferences: and of this difficulty I conceive there may be four reaſons, though they do not all, nor perhaps moſt of them, occur in each particular caſe.

And firſt, the whole animal itſelf, the uſe of whoſe particular parts is under inquiry, is but a part of that greater body, the univerſe; and therefore cannot eaſily be ſuppoſed to have been framed and furniſhed with the parts it conſiſts of, merely for its own ſake. And when we ſay, that all its parts are contrived for the beſt advantage for the animal, I conceive it to be underſtood in this limited ſenſe; that the parts are excellently framed for the welfare of the animal, as far forth, as that welfare is conſiſtent with the general ends of the Author of nature, in the conſtitution and government of the univerſe; which ends, becauſe they relate to the whole world, or to very conſiderable maſſes of it, as the terraqueous globe, the planets and other ſtars, I have formerly, for brevity's ſake, ſtiled coſmical: and though it has not been proved, that none of theſe coſmical ends are inveſtigable by us, yet to diſcover them all, is not an eaſy taſk. And yet it ſeems preſumptuous to ſuppoſe, that the welfare of particular animals is any further deſigned and provided for, than will conſiſt with the coſmical ends of the univerſe, and the courſe of God's general providence, to which his ſpecial or particular providence, about this or that mere animal, ought in reaſon to be ſubordinated. And though I think it a great raſhneſs for us men to determine poſitively, and excluſively to others, what ends the omniſcient Creator propoſed to himſelf, in giving to the world the frame we ſee it has; yet, as far as I can hitherto diſcern, I ſee nothing, that is more likely to have been one grand motive of ſo great a variety, as we may obſerve in his corporeal works, eſpecially in animals, than that which hath in part been elſewhere intimated, *viz.* that he might, by ſo many and ſo very differing contrivances, as are to be met with in the ſtructure of men, four-footed beaſts, birds, fiſhes, reptiles, *&c.* exerciſe and diſplay (what could not be by a leſs variety ſo fully manifeſted) that, which an apoſtle, ſpeaking of things of another order, emphatically ſtiles the πολυποίκιλος σοφία τοῦ Θεοῦ (the multifarious or manifold wiſdom of God.) Epheſ. iii. 10. Man being acknowledged, upon the account of his very body, the moſt perfect of animals, if God had ſimply deſigned the giving of every animal the moſt advantageous ſtructure, that could be deviſed, it ſeems, that he ſhould have made no other animals than men. But then there could not have been that diverſity of contrivance among living *automata*, that does ſo much recommend the wiſdom of him, that could frame ſo many and ſo differing animals, though not all of them equally perfect, yet all of them admirably furniſhed for thoſe purpoſes, to which he deſtinated them. And therefore it does not argue any want of providence, that he has not furniſhed man with wings, as he hath birds; nor fiſhes with four feet; nor birds with fins and ſcales; becauſe theſe parts would have been either ſuperfluous and burthenſome, or would not have ſuited with his deſign, of making ſome animals live on the earth, and ſome in the water: and if he deſigned any to live, though not equally, in both, he furniſhed them with parts of a peculiar ſtructure, as I have elſewhere noted of the beaver and the frog. If it were not for the fore-mentioned conſideration, it would be hard to give a reaſon, why vegetables were not made the food of all animals; but ſome ſhould be carnivorous, and furniſhed with appetites and organs to devour others, and live as birds and beaſts of prey do, upon the deſtruction of the weaker. And it will be hard to ſhew, why, even in animals of the ſame kind, the ſafety of ſome ſhould be ſo much better provided for, than that of others; as we ſee, that ſome ants, and ſome glow-worms, are furniſhed with wings, and ſome not. And in mankind itſelf, thoſe of the female ſex are not ſo happily framed, in order to their own welfare, as thoſe of the maſculine: ſince the womb, and other things peculiar to women, which are not neceſſary to the good of individual perſons, but to the propagation of their ſpecies, ſubject that tender ſex to a whole ſet of diſeaſes, belonging to them either peculiarly, as they are women, or as they are with child, or brought to-bed; from all which men are exempt. So that, to apply theſe things to our preſent purpoſe, men may ſometimes miſtake, when they peremptorily conclude, that this or that part of an animal muſt, or cannot have been framed for ſuch an uſe, without conſidering the coſmical, and therefore primary and over-ruling ends, that may have been deſigned by nature in the conſtruction of the whole animal.

SECONDLY, men ſometimes erroneouſly conclude, that ſuch an office cannot belong to ſuch a part, becauſe they think it is not ſo commodiouſly framed for it, as may be wiſhed or deviſed; without conſidering, whether the ſtructure, which they fancy would do better for that particular uſe, would not, in ſome other as conſiderable regard, oppoſe the welfare of the animal; or, whether it would be conſiſtent with the other uſes deſigned by nature in that ſort of living creatures. For in the living works of ſo excellent an engineer as nature, it muſt not be expected, that any particular end ſhould be proſecuted to the prejudice of the whole; but rather it muſt be ſuppoſed, that ſhe aims not only at particular expedients, but univerſal ſymmetry; and does indeed excellently fit the ſeveral parts for their reſpective offices, but yet only as far forth, as a due regard to the deſign and welfare of the whole will permit. The reaſonableneſs of this obſervation, one need but be moderately exerciſed in zootomy (as that is diſtinguiſhed from androtomy) to diſcern. For though man be confeſſed to be the moſt perfectly framed animal in the world, yet his body is not made the model, on which nature has framed the correſpondent parts of other animals. The lungs of dogs, of birds, of frogs and vipers, and I know not how many others, are of a ſtructure very differing from thoſe of man. He is not furniſhed with ſo many ſtomachs as an ox or a ſheep, becauſe nature intended not he ſhould ruminate like them. Though his gall be lodged in a peculiar bag, ſo placed in the liver, as to give *Helmont* a colour to call it *nucleus hepatis*, yet it were unadviſed to ſay, that the ſecretion of gall is none of the uſes of thoſe livers, wherein ſuch a cyſtis is not to be met with; ſince in ſome animals, as in horſes and pigeons, that bitter humour, (which in frogs I have often obſerved to be of a deep and tranſparent green) is not uſually, as in man, collected into one bag: and in vipers, though it be included in one cyſtis, yet, as far as I have obſerved, that bag does not at all touch the liver: and ſtore of ſuch inſtances may be met with among the remarks of zootomiſts: wherefore I paſs on to obſerve,

THAT, in the third place, it is difficult to determine the true and primary uſe of a part, becauſe nature does often fit one part for ſeveral uſes. To which I ſhall add,

IN the fourth place, that the difficulty is ſometimes increaſed, becauſe nature may compaſs the ſame end by ſeveral means, each of them ſufficiently, though not equally commodious. I join theſe two together, becauſe, in effect, they do often concur in making it difficult to determine the true uſe of a part. And the latter of theſe two is ſometimes increaſed by this, that nature does not as conſtantly, as ſome men preſumes ſhe does, employ only one part to perform ſuch an office; but the intended effect is ſometimes produced by a ſeries of ſucceſſive operations, to which ſeveral parts may, in differing manners, contribute.

AND here I obſerve, (what perhaps has not been conſidered) that neither the mechaniſm of a human body, nor that of very conſiderable parts of it, is to be judged of only by the ſtructure of the viſible parts, whether they be thoſe ſolid or ſtable ones, that the anatomiſt's knife is wont to expoſe to ſight; or even by the texture of thoſe fluid ones, which are to be found in the veſſels and cavities of a dead body, when diſſected, though never ſo ſkilfully. For I take the body of a living man to be a very compounded engine, ſuch as mechanicians would call *hydraulico-pneumatical*; many of whoſe functions, (if not the chiefeſt,) are performed, not by the blood and other viſible fluids barely as they are liquors, but partly by their circulating and other motions, and partly by a very agile and inviſible ſort of fluids, called ſpirits, vital and animal, and partly perhaps, (as I have ſometimes gueſſed) by little ſpringy particles; and perhaps too, by ſomewhat, that may be called the vital portion of the air; and by things analogous to local ferments; the important operations of all which are wont to ceaſe with life, and the agents themſelves are not to be diſcerned in a dead body. So that beſides theſe manifeſt uſes, which the viſible fabric of the engine may ſuggeſt to an anatomiſt, there may be chymical uſes (if I may ſo call them) of ſome parts, that ſerve for the elaboration of ſpirits and other fluids: which uſes, (as it was formerly obſerved, and yet ought to be inculcated) are not ſuggeſted to the anatomiſts, as ſuch, by the inſpection of the ſtructure of the parts; but to diſcern them may require no mean ſkill in ſpagyrical principles and operations.

SUCH conſiderations as the foregoing make me think it more difficult than many do, to determine, with any certainty, the main uſe of divers particular parts, [for in ſome others it ſeems manifeſt enough;] eſpecially if it be done with the excluſion of other uſes. Nor is it enough to ſecure us, that we know the chief function and end of a part, to know, that is contrived for ſuch a purpoſe: for upon the things I have lately repreſented, one may ground this anſwer, that this fitneſs hinders not, but that the primary uſe of the part may be another, (as not anatomical, but chymical, or *vice verſa*) more conducive to the general welfare of the animal, or elſe to the coſmical ends of nature. And it ought not to ſeem ſtrange, that ſome pieces of workmanſhip, that conſiſt of many parts, all of them curiouſly contrived, may by one learned man be gueſſed to be intended for this uſe, and by others for that uſe; and yet both theſe uſes may be worthy of the artificer.

WHEN ſome very politic prince does ſome great thing, without declaring why, the gueſſes of the ſtateſmen are often very differing, whilſt yet none of them aſcribe to him a deſign miſ-becoming a wiſe man. And ſo, when a learned author expreſſes himſelf, as ſometimes it happens, ambiguouſly, though one reader interprets his words to this ſenſe, and another to that, yet both the ſenſes pitched on may fairly comport with the context, and the main ſcope of the writer. Theſe things I ſay, becauſe I would by no means diſparage the wiſdom of nature, by propoſing the difficulties I have hitherto mentioned; though I confeſs, that, upon the account of theſe and ſome others, I look upon many of the arguments, that ſeveral authors have made bold to draw from final cauſes, but as conjectural things. And in divers caſes I allow what is ſuggeſted to me upon the ſuppoſition of the intended uſes of particular parts, rather as good hints to excite, and give ſome aim to, a ſeverer inquiry, than as ſafe grounds to build phyſical concluſions on.

I NOW come to the laſt caution I would recommend to you, about the conſideration of *Final Cauſes*; and I ſhall preſent it you in the following propoſition.

PROPOSITION V.

That the naturaliſt ſhould not ſuffer the ſearch, or the diſcovery of a Final Cauſe *of Nature's works, to make him under-value or neglect the ſtudious indagation of their efficient cauſes.*

IT is true, that to inquire to what purpoſe nature would have ſuch or ſuch effects produced, is a curioſity worthy of a rational creature, upon the ſcore of his being ſo: but this is not the proper taſk of a naturaliſt, whoſe work, as he is ſuch, is not ſo much to diſcover, why, as how, particular effects are produced. A country-fellow here in *England* knows ſomething of a watch, becauſe he is able to tell you, that it is an inſtrument, that an artificer made to meaſure time by; and that is more than every American ſavage would be able to tell you; and more than thoſe civilized Chineſes knew, that took the firſt watch the Jeſuits brought thither, for a living creature. But the Engliſh countryman, that knows no more of a watch, than that it was made to ſhew the hour of the day, does very little underſtand the nature of it. And whereas the two ſcopes, that men are wont to aim at in the ſtudy of phyſics, are to underſtand how, and after what manner nature produces the phænomena we contemplate; and, in caſe it be imitable by us, how we may, if occaſion require, produce the like effect, or come as near it as may be; theſe ends cannot be attained by the bare knowledge of the final cauſes of things, nor of the general efficient: but to anſwer thoſe aims, we muſt know the particular efficients, and the manner and progreſs of their operating, and what diſpoſitions they either find or produce in the matter they work upon. As he, that would throughly underſtand the nature of a watch, muſt not reſt ſatisfied with knowing in general, that a man made it, and that he made it for ſuch uſes; but he muſt particularly know, of what materials the ſpring, the wheels, the ſtring or chain, and the balance are made: he muſt know the number of the wheels, their bigneſs, their ſhape, their ſituation and connexion in the engine, and after what manner one part moves the other in the whole ſeries of motions, from the expanſive endeavour of the ſpring to the motion of the index, that points at the hours. And much more muſt a mechanician know this, if he means to be able to make a watch himſelf, or give ſufficient inſtructions to another man, that is more handy to do it for him. In ſhort, the neglect of efficient cauſes would render phyſiology uſeleſs; but the ſtudious indagation of them will not prejudice the contemplation of final cauſes: for, ſince it is truly ſaid, if it be rightly underſtood, that *opus naturæ eſt opus intelligentiæ*, the wiſe Author of nature has ſo excellently contrived the univerſe, that the more clearly and particularly we diſcern, how congruous the means are to the ends to be obtained by them, the more plainly we diſcern the admirable wiſdom of the omniſcient Author of things; of whom it is truly ſaid by a prophet, that *he is wonderful in counſel, and excellent in working*. Iſa. xx. 29. Nor will the ſufficiency of the intermediate cauſes make it needleſs to admit a firſt and ſupreme cauſe; ſince (to inculcate, on this occaſion, what I more fully deliver in another paper) that order of things, by virtue of which theſe means become ſufficient to ſuch ends, muſt have been at firſt inſtituted by an intelligent cauſe. And if it be irrational to aſcribe the excellent fabric of the univerſe, ſuch as it now is, and the actions, that have manifeſt tendencies to determinate uſeful ends, to ſo blind a cauſe as chance; it will be rather more than leſs irrational, to aſcribe to chance the firſt formation of the univerſe, of which the preſent ſtate of things is but the natural conſequence or effect: for it may indeed be plauſibly ſaid, that, in the preſent ſtate of things, the ſeveral parts of the univerſe are, by the contrivance of the whole, determined, and thereby qualified to attain their ends. But it cannot be rationally pretended, that at the firſt framing of the world, there was a ſufficiency in the ſtupid materials of it, without any particular guidance of a moſt wiſe Superintendent, to frame bodies ſo excellently contrived and fitted to their reſpective ends.

The CONCLUSION.

THE reſult of what has been hitherto diſcourſed, upon the four queſtions propoſed at the beginning of this ſmall treatiſe, amounts in ſhort to this:

THAT all conſideration of final cauſes is not to be baniſhed from natural philoſophy; but that it is rather allowable, and in ſome caſes commendable, to obſerve and argue from the manifeſt uſes of things, that the author of nature pre-ordained thoſe ends and uſes.

THAT the ſun, moon, and other cœleſtial bodies, excellently declare the power and wiſdom, and conſequently the glory of God; and were ſome of them, among other purpoſes, made to be ſerviceable to man.

THAT from the ſuppoſed ends of inanimate bodies, whether cœleſtial or ſublunary, it is very unſafe to draw arguments to prove the particular nature of thoſe bodies, or the true ſyſtem of the univerſe.

THAT as to animals, and the more perfect ſorts of vegetables, it is warrantable, not preſumptuous, to ſay, that ſuch and ſuch parts were pre-ordained to ſuch and ſuch uſes, relating to the welfare of the animal (or plant) itſelf, or the ſpecies it belongs to: but that ſuch arguments may eaſily deceive, if thoſe, that frame them, are not very cautious, and careful to avoid miſtaking, among the various ends, that nature may have in the contrivance of an animal's body, and the various ways, which ſhe may ſucceſsfully take to compaſs the ſame ends. And,

THAT, however, a naturaliſt, who would deſerve that name, muſt not let the ſearch or knowledge of final cauſes make him neglect the induſtrious indagation of efficients.

SOME UNCOMMON
OBSERVATIONS
ABOUT
VITIATED SIGHT.

ADVERTISEMENT.

THE following obſervations were not written with intention, that they ſhould be annexed to the foregoing eſſay, but to gratify a philoſophical phyſician: which is the reaſon, why, beſides thoſe things, that are more purely optical, I thought fit to mention ſome others, that might be either uſeful or grateful to an inquiſitive man of his profeſſion. But having allowed the ſtationer to expect, that this book, though it have for title but an eſſay, ſhould not be of too inconſiderable a bulk, I made choice of theſe papers, among ſeveral, that lay by me, to increaſe the bigneſs of the book; becauſe that the eyes being thoſe parts of the bodies of men and other animals, that I pitched upon in the foregoing treatiſe to ſtrengthen the doctrine delivered in it about final cauſes, it ſeemed ſuitable enough to my ſubject and deſign, to mention ſome uncommon things, that related to viſion or the organs of it, that we may be invited both to admire the wiſdom of God, which, to furniſh man with a ſenſe, that requires the concourſe of ſo very many things, has, if I may ſo ſpeak, crowded them into ſo ſmall an engine as an eye; and to celebrate his goodneſs too, which has been diſplayed in that, notwithſtanding that the eye is ſo very compounded a part, and the ſight ſo eaſily vitiated, yet the moſt part of men by far do, from their cradles to their graves, enjoy the benefit and comfort of ſo neceſſary and noble a ſenſe.

Obſervations about Vitiated Sight.

Observation I.

EXAMINING a gentleman, that was already almoſt blind, and feared to grow altogether ſo, about the ſymptoms of his diſeaſe, (which came with a ſtroke upon his head,) I found, as I expected, by his anſwers, that, though he could not any thing well diſtinguiſh objects of other colours, yet he could well perceive thoſe, that were white, to be of that colour: which confirms what I mention in the hiſtory of colours, concerning the great quantity of light, that is reflected by white objects, in compariſon of thoſe, that are otherwiſe coloured. And this obſervation itſelf was confirmed by another patient, who, though almoſt blind, could yet diſcern white objects.

Observation II.

I knew a gentleman, that had a cataract growing, which, when I looked on his eye in a lightſome place, appeared to cover almoſt juſt the upper part of the pupil; and though he were a young vigorous perſon, and the weather was very clear, he could not well diſcern men from women croſs the ſtreet. But this gentleman's misfortune came by a great ſtroke he received on that ſide of his head, whereof he ſhewed me the ſcar; which circumſtance I therefore note, becauſe when no outward violence has been offered to the eye, it has been obſerved by a good oculiſt; and, if I miſremember not, I have ſeen an inſtance of it, that a ſmall part of the pupil, left uncovered by the cataract, would ſerve for more ſight than the gentleman enjoyed. In him likewiſe I had a further confirmation of what I was lately obſerving about the conſpicuouſneſs of white objects: for though he could not, as I was ſaying, diſcern men and women, that paſſed by on the other ſide of the ſtreet, yet having once deſired him to tell me, if he could diſtinguiſh any object there, he told me that he could; and that I might no longer doubt of it, when I aſked him what he ſaw, he ſaid, that it was a woman, that paſſed by with a white apron; which apron he ſaw directly, and therefore might eaſily conclude, without diſtinctly ſeeing the wearer, that the perſon, that wore it, was a woman.

Observation III.

Meeting accidentally with a man, by profeſſion a farrier, whoſe eyes looked very oddly, I queſtioned him about his diſtemper; and found by his anſwers, that he had had cataracts in both his eyes, but either had them ill couched, or had not behaved himſelf orderly afterwards: for there ſeemed ſtill to be ragged films, that covered conſiderable portions of his pupils; inſomuch, that I ſomewhat wondered to ſee him go freely about, as he did, without requiring any body to help him, ſo much as up or down ſtairs: and I hereupon aſking him, whether he were able to read in a large print, he told me he was, with the help of his cataract ſpectacles, as they call them; which I doubting of, brought him a book, whoſe title page he was not able to read. This he excuſed by ſaying, that the place was too lightſome, which though it did not ſeem to others, yet conſidering, that it was about noon, I cauſed the room to be a little darkened, and then perceived, that indeed he could read well enough.

Observation IV.

A gentleman, having in a quarrel received a ſtroke on one ſide of his head, which knocked him down, found afterwards a great weakneſs and dimneſs in his eyes; into which when I looked attentively, I plainly diſcerned, that though above one half of his pupil was yet uncovered, ſo that, when he looked downwards, he could ſee well enough with that eye, yet there was grown in it no leſs than two cataracts, which, when I looked on them attentively, and in a good light, I could manifeſtly perceive to be diſtinct; the one of them ſeeming to be ſmooth ſpread, as if its circular edge adhered cloſely to the inſide of the eye; and the other, that ſeemed not altogether of the ſame colour, hanging looſely, and as it were a rag, at ſome diſtance above it. What afterwards became of this gentleman I could not learn, though I would gladly have done it; two cataracts at a time in one eye being ſomewhat extraordinary.

Observation V.

A learned gentleman coming once to viſit me, with deſign, as I afterwards perceived, to hear my opinion concerning an odd diſtemper he had in his eyes; I found by diſcourſing with him concerning the phænomena of his diſeaſe, that though, when he looked on objects near at hand, he ſaw them ſomewhat dimly, but yet ſingle, yet there were ſome objects, particularly poſts and rails, which, when he beheld at a certain diſtance (which was not very great) they appeared to him both more dark and double. I found alſo, that he complained of divers black flies and little leaves, that paſſed now and then before his eyes; which though they do not always fore-bode a true cataract, ſince others and I alſo have obſerved them to continue many years, without being more than a baſtard ſuffuſion (as phyſicians ſpeak) yet in him they were probably forerunners of a true cataract; in regard that I have known it obſerv'd by a ſkilful oculiſt, that ſome perſons, before their cataract, have complain'd, that at ſome diſtances they ſaw objects almoſt double; ſo that looking at one's head, they thought they ſaw a great part of a dark head a little above it; which deſcription, whether it proceeded from ſome refractions made by the yet not uniformly opacous matter of the cataract, not having opportunity to examine thoſe perſons my ſelf, I dare not venture to ſay.

Observation VI.

It may be worth obſerving, how long the better ſort of cataracts, tho' they hinder ſight for a time, as a thick curtain drawn croſs the pupil, yet may remain in the eye, without ſpoiling the optic nerve or hindring viſion, when once the cataract is remov'd; of which I remember, among other inſtances, I took notice in the caſe of a woman, who told me ſhe had cataracts in her eyes ſo long, that ſhe was brought to-bed of ſix children conſecutively, without being able to ſee any one of them, till after ſhe was cured by having the cataracts couched. But then ſhe ſaw ſo well, that with ſpectacles ſhe could read in a portable bible of a ſmall print. And divers conſiderable perſons of my acquaintance ſaw one of eighteen years old, born with cataracts in both her eyes, who not naturally wanting the faculty of ſeeing, though thus hindered of the exerciſe of it, had been ſo happily couched, as afterwards to have the benefit of ſight in them both.

Observation VII.

It has been of late the opinion of very learned men, that though both our eyes be open and turned towards an object, yet it is but one of them at a time, that is effectually employed in giving us the repreſentation of it. Which opinion, in this place, where I am writing but obſervations, it were not proper to diſcuſs; eſpecially becauſe what is ſuppoſed to be obſerved, will not always uniformly happen, but may much vary in particular perſons, according to their ſeveral cuſtoms, and the conſtitution of their eyes. For I have, by an experiment purpoſely made, ſeveral times found, that my two eyes together ſee an object in another ſituation, than either of them apart would do. On the other ſide, I met with a perſon, who told me he had a cataract in his eye for two years, without diſcerning, that he had any ſuch impediment in either of his eyes; and when I aſked him, how he knew that, he anſwered me, that others had taken notice of a white film, that croſſed his eye, ſo long before he himſelf did; but not knowing what a cataract was, and not finding him to complain of it at all himſelf, the thing remained unheeded, till the patient having one day occaſion to rub his ſound eye, whilſt the lid covered it, was ſadly ſurprized to find himſelf altogether in the dark; and then reſorting to an oculiſt, was aſſured it was a cataract, which, a while before I met with him, had been couched. But notwithſtanding this relation, what I had tried about the uſing of both eyes, made me aſk of a very ingenious perſon, that by an accident had ſome months before one of his eyes ſtruck out, whether he did not obſerve, that upon the being confined to the uſe of one eye, he was apt to miſtake the ſituation and diſtances of things. To which he anſwered me, that having frequently occaſion to pour diſtill'd waters and other liquors out of one vial into another, after this accident he often ſpilt his liquors, by pouring quite beſide the necks of the vials he thought he was pouring them directly into. Afterwards inquiring of a gentleman, that was a good-fellow, and had by a wound a while before loſt the uſe of one of his eyes, he confeſſed to me, that divers times pouring the wine out of one veſſel into another, he would miſs the orifice of the bottle or glaſs, that ſhould receive it, and expoſe himſelf to the merriment of the company. A yet more conſiderable inſtance of ſuch miſtakes I afterwards had from a noble perſon, who having in a fight, where he played the hero, had one of his eyes ſtrangely ſhot out, by a muſket-bullet, that came out at his mouth, anſwered me, that not only he could not well pour drink out of one veſſel into another, but had broken many glaſſes, by letting them fall out of his hand, when he thought he had put them into another's, or ſet them down upon a table: and he added, that this aptneſs to miſjudge of diſtances and ſituations continued with him, though not in the ſame degree, for little leſs than two years. But on this occaſion I ſhall take notice, that I have often employed a dextrous artificer, whoſe right eye (for in his left there is nothing more remarkable) is conſtantly drawn ſo much a ſide towards the greater angle of the eye, that the edge of the pupil does almoſt touch it, and one would think it ſcarce poſſible, but that he ſhould ſee the object double with two eyes, that ſeem ſo very differingly turned; and yet he anſwered me, that he does not ſee at all, nor that he finds any inconvenience, ſave the deformity of this unuſual ſituation of his right eye, which hinders him not from reading freely as other men. This accident happened to him by an unwary miſtake of ſublimate for another thing; after which, it ſeems, one of the muſcles, that moved the eye, remained contracted: but this having happened to him, as I found by inquiry, ever ſince he was two years of age, he could not remember, whether he had ſeen objects double, before he was accuſtomed to judge of them by the help of his other ſenſes, and the information of others.

Observation VIII.

It may be worth while to obſerve, that a very great diſtention may be made of the parts of the eye, without ſpoiling the ſight; of which I lately ſaw an inſtance in a patient of that ingenious and experienced oculiſt, Dr. *Turbervill*. This was a gentlewoman of about one or two and twenty years of age, whoſe complexion and features would have made her handſome, if ſhe had not had that ſort of eyes, which, though rarely met with, ſome call ox-eyes; for hers were ſwelled much beyond the ſize of human eyes, inſomuch, that ſhe complained they often frighted thoſe, that ſaw her, and were indeed ſo big, that ſhe could not move them to the right hand or the left, but was conſtrained to look ſtraight forward; or if ſhe would ſee an object, that lay aſide, ſhe was obliged to turn her whole head that way. And ſo ſhe anſwered me ſhe was, when ſhe ſet herſelf to read in a book, unleſs ſhe did with her hand move the book from one ſide to another, to bring the ends of the lines directly before her eyes. She told me her eyes did not always retain the ſame meaſure of tumidneſs, and that the very day I ſaw them, they had been in the morning much more ſwelled, than when I looked upon her. But that, which was more remarkable, was, that not only ſhe could, for all this, ſee very well and diſtinctly, and, as I juſt now intimated, could read books, but her ſight had continued good, though ſhe had this diſtemper theſe twelve years. And, which is more ſtrange, ſhe anſwered me, that her viſive power was ſo little prejudiced by this diſtemper, when it firſt came upon her, that ſhe never knew any thing was amiſs in her eyes, till her friends told her of it, when they found it had continued too long to be a meerly caſual and tranſient tumor. But though this odd accident did not impair her ſight, it occaſioned great pains in her eyes, for which ſhe took purging and other medicines with ſo little ſucceſs, that both ſhe and her former phyſicians thought her caſe deſperate, there appearing no way of diſlodging a humour ſo long ſettled there. Upon which I propoſed ſalivation, as the leaſt unlikely way, that remained, to reſolve and carry off the peccant humour: but this, though much approved by her doctor, the modeſt patient would by no means conſent to.

OBSERVATION. IX.

I ONCE looked into the eyes of a gentlewoman, where I could diſcern nothing, that was amiſs, or any thing, that was unuſual, ſave the narrowneſs of her pupils, which is often eſteemed a good ſign; and yet this woman was much troubled with fumes and weakneſſes of the head, and had a diſaffection of ſight very uncommon; for ſhe told me, that, whereas in the day time her ſight was ſo dim, that ſhe could hardly diſcern her way, ſoon after ſun-ſet, and during the twilight, ſhe could diſcern things far better: and in this condition ſhe had continued a good while. In which odd caſe, whether the ſmallneſs of her pupils, which might poſſibly be contracted too much by the day-light, and might be expanded by the receſs of ſo much light; or the greater diſſipation of the viſive ſpirits at one time than at the other, may have any intereſt, I ſhall not now ſtay to inquire. But this patient brings into my mind the rare caſe of a learned old divine, who complained to me, that he was forced to write his letters and books by night, becauſe, during the day-time his right hand ſhook ſo much, that he could not manage a pen, and therefore was forced to make uſe of it only by candle-light. And I remember, that upon his preſſing me to propoſe ſome poſſible cauſe of ſo odd a phænomenon, I told him, to put him off, that perchance the few animal ſpirits, that he had to move his hands with, were ſo ſubtle, as to be diſſipated or exhaled by the warmth of the day, but were kept in by the coldneſs of the night, that ſomewhat conſtipated his pores; and commended to him the uſe of ſtrengthening things, and, among the reſt, of chocolate; which when for ſome time he had continued to drink, he came to me, and told me with joy, that he began again to be able to write in the day, and ſo I think he can do yet. But this upon the by.

OBSERVATION X.

BEING acquainted with two ladies of very diſtant ages, but very near of kin, who were both of them troubled with diſtempers, that made me gueſs their eyes might ſometimes be oddly affected, I inquired of them, whether they were not troubled with ſudden apparitions of flame or fire? to which one of them anſwered me, that oftentimes there would appear to her multitudes, as ſhe fancied, of ſparks of fire, that were very unwelcome to her. And the other lady, that was ſubject to convulſive, but not epileptick, fits, told me, ſhe divers times ſaw, as ſhe fancied, ſuch flaſhes of fire, as I had mentioned, paſs before her eyes, which at firſt did not a little frighten her.

OBSERVATION XI.

THE following obſervation is odd enough, to give riſe to ſome curious ſpeculations and diſputes; and therefore I choſe to ſet it down as I found it among my *adverſaria*, though I ſuſpect part of it to have been loſt, that the relation may be the more unbiaſſed, though, if I had another opportunity to diſcourſe with the patient, I ſhould, upon ſecond thoughts, have aſked ſome queſtions, and written down ſome circumſtances, that I now wiſh had not been omitted.

THE gentlewoman I ſaw to day, ſeems to be about eighteen or twenty years old, and is of a fine complexion, accompanied with good features. Looking into her eyes, which are grey, I could not diſcern any thing, that was unuſual or amiſs; though her eye-lids were ſomewhat red, whether from heat, or, which ſeemed more likely, from her precedent weeping. During the very little time, that the company allowed me to ſpeak with her, the queſtions I propoſed to her were anſwered to this effect:

THAT about five years ago having been, upon a certain occaſion, immoderately tormented with bliſters, applied to her neck and other parts, ſhe was quite deprived of her ſight.

THAT ſome time after ſhe began to perceive the light, but nothing by the help of it; that then ſhe could ſee a window, without diſcerning the panes or the bars: that afterwards ſhe grew able to diſtinguiſh the ſhapes of bodies, and ſome of their colours: and at laſt ſhe came to be able to ſee the minuteſt object; which when I ſeemed to doubt of, and preſented her a book, ſhe not only without heſitancy read in it a line or two, (for her eyes are quickly weary) but having pointed with my finger at a part of the margin, near which there was the part of a very little ſpeck, that might almoſt be covered with the point of a pin, ſhe not only readily enough found it out, but ſhewed me at ſome diſtance off another ſpeck, that was yet more minute, and required a ſharp ſight to diſcern it. And yet, whereas this was done about noon, ſhe told me, that ſhe could ſee much better in the evening, than in any lighter time of the day.

WHILE ſhe was looking upon the printed paper I ſhewed her, I aſked her, whether it did not appear white to her, and the letters black? to which ſhe anſwered, that they did ſo; but that ſhe ſaw, as it were, a white glaſs laid over both the objects. But the things, that were moſt particular and odd in this woman's caſe, were theſe two. The firſt is, that ſhe is not unfrequently troubled with flaſhes of lightning, that ſeem to iſſue out like flames about the external angle of her eye, which often make her ſtart, and put her into frights and melancholy thoughts. But the other, which is more ſtrange and ſingular, is this, that ſhe can diſtinguiſh ſome colours, as black and white, but is not able to diſtinguiſh others, eſpecially red and green; and when I brought her a bag of a fine and gloſſy red, with tufts of ſky-coloured ſilk, ſhe looked attentively upon it, but told me, that to her it did not ſeem red, but of another colour, which one would gueſs by her deſcription to be a dark or dirty one: and the tufts of ſilk, that were finely coloured, ſhe took in her hand, and told me they ſeemed to be a light-colour, but could not tell me which; only ſhe compared it to the colour of the ſilken ſtuff of the laced petticoat of a lady, that brought her to me; and indeed the blews were very much alike. And when I aſked her, whether in the evenings, when ſhe went abroad to walk in the fields, which ſhe much delighted to do, the meadows did not appear to her cloathed in green? ſhe told me they did not, but ſeemed to be of an odd darkiſh colour; and added, that when ſhe had a mind to gather violets, though ſhe kneeled in that place, where they grew, ſhe was not able to diſtinguiſh them by the colour from the neighbouring graſs, but only by the ſhape, or by feeling them. And the lady, that was with her, took thence occaſion to tell me, that when ſhe looks upon a turky carpet, ſhe cannot diſtinguiſh the colours, unleſs of thoſe parts, that are white or black. I aſked the lady, whether ſhe were not troubled with female obſtructions? to which ſhe anſwered me, ſhe was not now, but that formerly ſhe had been much ſubject to them, having been obſtinately troubled with the green ſickneſs.

OBSERVATION XII.

I SHALL add on this occaſion ſomething, that, though not ſo odd as it, has yet an affinity with the newly recited caſe, and ſo may make it the more credible. And it is, that I lately converſed with a mathematician, eminent for his ſkill in opticks, and therefore a very competent relator of phænomena belonging to that ſcience, whoſe organs of viſion are ſo conſtituted, that though in his eyes I could diſcern nothing amiſs, and though he makes much and excellent uſe of them in aſtronomical obſervations and optical experiments, yet he confeſſes to me, that there are ſome colours, that he conſtantly ſees amiſs, and particularly inſtanced in one, which in a clear day, (for ſo it was, when we diſcourſed together of this matter) ſeemed to him to be the ſame with that of a darkiſh ſort of cloth, that he then wore, whilſt to me and other men it appeared of a quite differing colour.

OBSERVATION XIII.

DISCOURSING with a lady, who had been very long troubled with a very unuſual indiſpoſition in her head, and, though ſhe looks well, is never without pain in it; though looking into her eyes, I perceived nothing amiſs, yet conjecturing, that ſo obſtinate a diſtemper muſt have had ſome unuſual influence upon her ſight, I learned by inquiry, that after the violent fits of pain and diſorder ſhe had from time to time in her head, if ſhe did but caſt her eyes, or turn them ſuddenly, from one ſide to the other, there would preſently enſue a convulſive motion in one of them, whereby it would not only be drawn away, but, which was very ſtrange, all white things, and moſt other objects, that ſhe looked on with that eye, appeared green to her: and yet this was not a tranſient diſcompoſure, that would go quickly off, but would moleſt her for a good while, and frequently returned upon her for a whole year; ſo that ſhe deſpaired of recovering the uſe of that eye, wherewith yet ſhe now ſees very well, though her cephalick diſtempers were rather mitigated than quite cured. And when I aſked her, whether, whilſt the convulſion of her eye laſted, ſhe did not ſee objects double? ſhe anſwered, that whilſt that diſtemper was upon her, if ſhe went to read in a book, the letters were ſo apt to appear double, that, when ſhe was bent upon reading, ſhe was fain to ſhut the diſtempered eye, and employ only the other.

Observation XIV.

Some may think, that a man has rather an excellent, than a vitiated ſight, who can ſee objects with a far leſs degree of light, than other men have need of to diſcern them. But though an extraordinary tenderneſs may be a kind of perfection in the eyes of bats and owls, whoſe uſual food may be more eaſily purchaſed by twilight; yet as to man, the main part of whoſe actions is to be performed by the light of the day, or ſome other almoſt equivalent, it may argue the provident goodneſs of the author of nature, to have given him eyes conſtituted as thoſe of men generally are: ſince that a very great tenderneſs of the *Retina*, or principal part of the organ of ſight, would be, if not an imperfection, at leaſt a great inconvenience, may appear by the memorable ſtory I am going to relate.

In the army of the late King of happy memory, (*Charles* the firſt) there was a gentleman of great courage and good parts, that was major to one of the regiments; who being afterwards by the prevailing Uſurpers forced to ſeek his fortune abroad, ventured to do his King a piece of ſervice at *Madrid*, which was of an extraordinary nature and conſequence, and there judged very irregular. Upon this he was committed to an uncommon priſon, which, though otherwiſe tolerable enough, had no window at all belonging to it, but a hole in the thickneſs of the wall, at which the keeper once or twice a day put in liberal proviſion of victuals and wine, and preſently cloſed the window, if it may be ſo called, on the out-ſide, but not perhaps very ſolicitouſly. For ſome weeks this poor gentleman continued in the dark, very diſconſolate. But afterwards he began to think he ſaw ſome little glimmering of light, which from time to time increaſed; inſomuch, that he could not only diſcover the parts of his bed, and other ſuch large objects, but at length came to diſcover things ſo minute, that he could perceive the mice, that frequented his chamber, to eat the crumbs of bread, that fell upon the ground, and diſcern their motions very well. Several other effects of his ſight in that dark place he related. And that, which confirms, that this proceeded mainly from the great tenderneſs the viſive organ had acquired by ſo long a ſtay in ſo obſcure a place, was, that when after ſome months, the face of affairs abroad being ſomewhat changed, his liberty was reſtored him, he durſt not leave his priſon abruptly, for fear of loſing his ſight by the dazzling light of the day; and therefore was fain to accuſtom his eyes by ſlow degrees to the light. This ſtrange, as well as once famous ſtory, I the leſs ſcruple to ſet down in this place, becauſe I had the curioſity to learn it from the gentleman's own mouth, who acquainted me with other particulars about it, that, for want of the notes I then took, I ſhall not now venture to ſpeak of.

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The END of the Fourth Volume.

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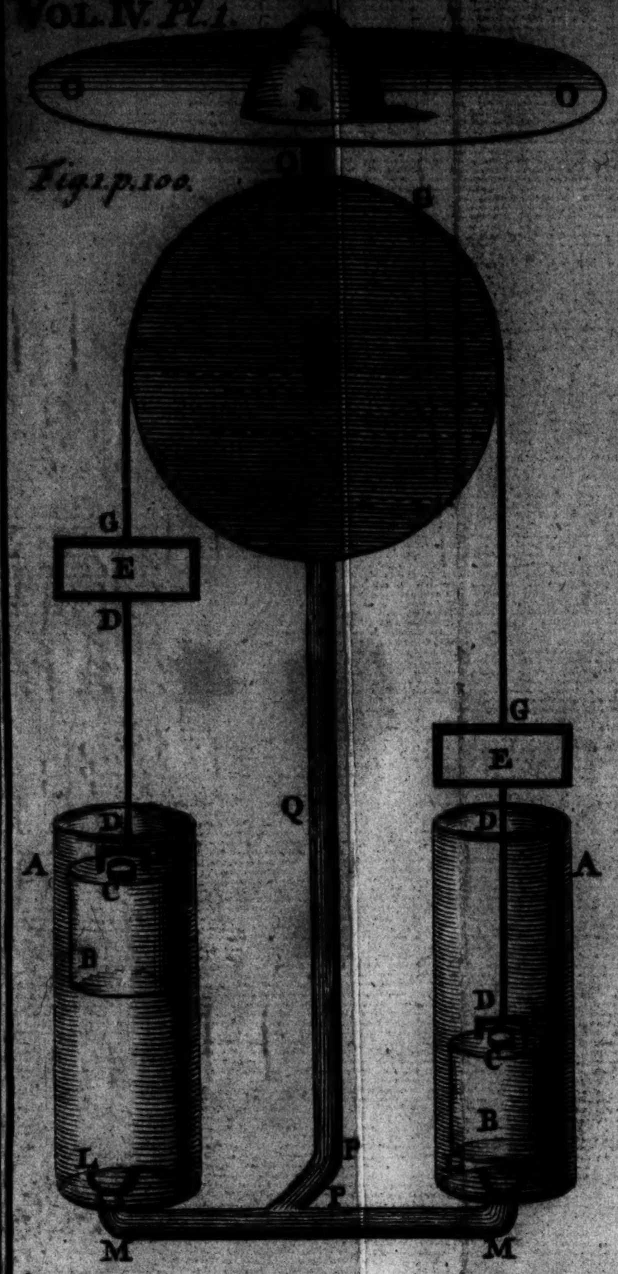
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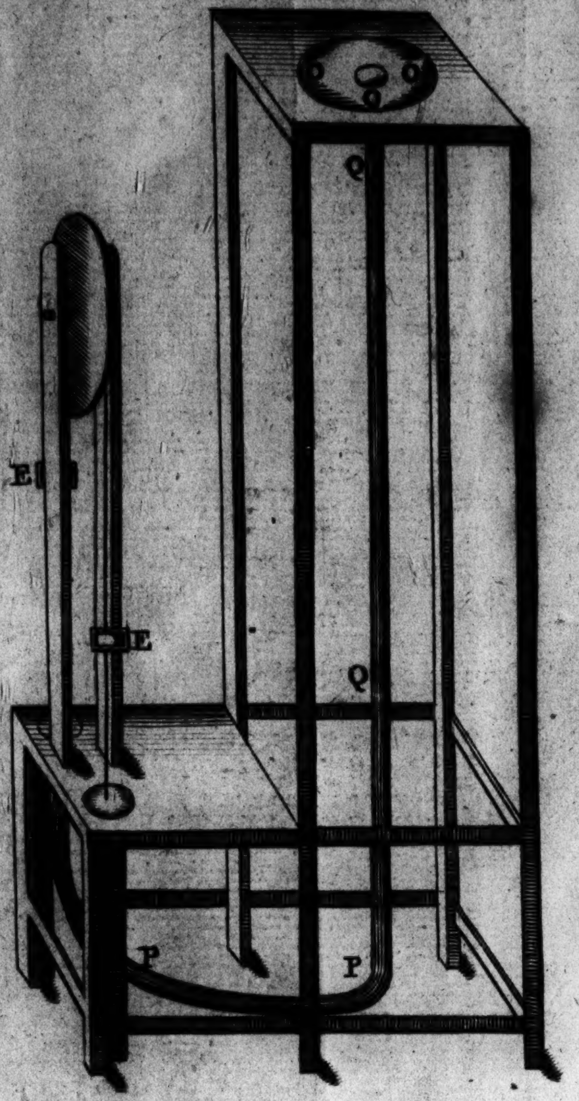
Fig. 1. p. 100.

Fig. 2. p. 100.



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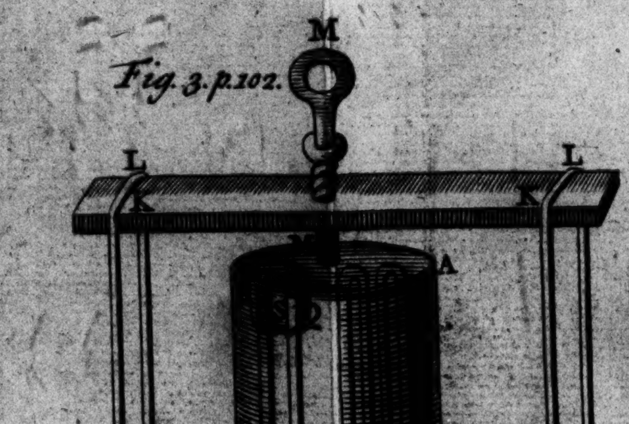
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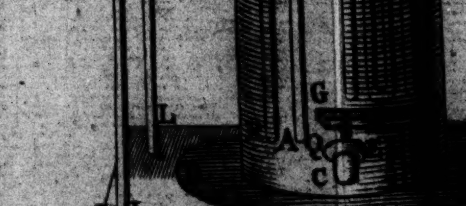

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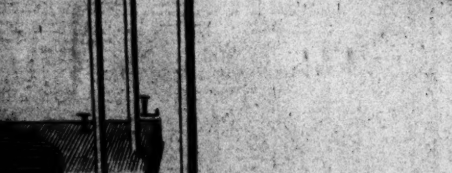

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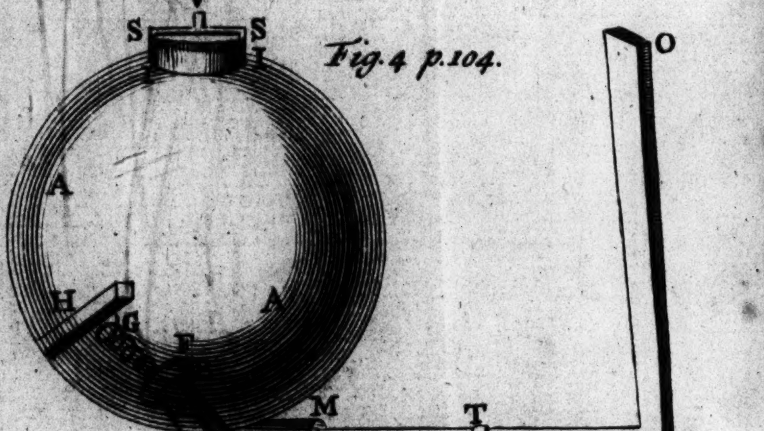
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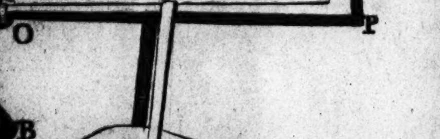
Fig. 2. p. 101.



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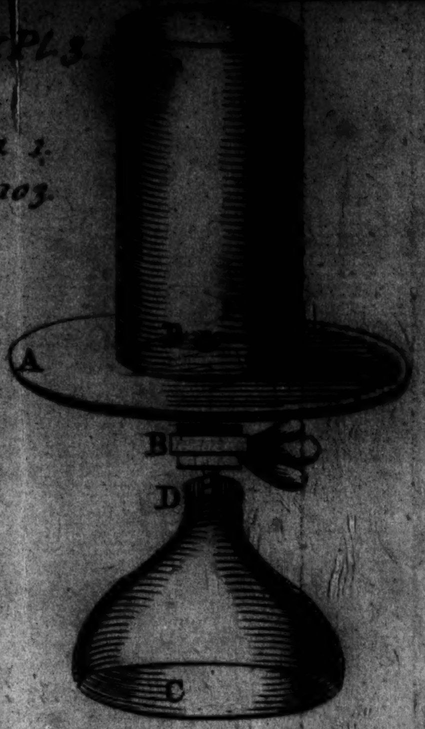
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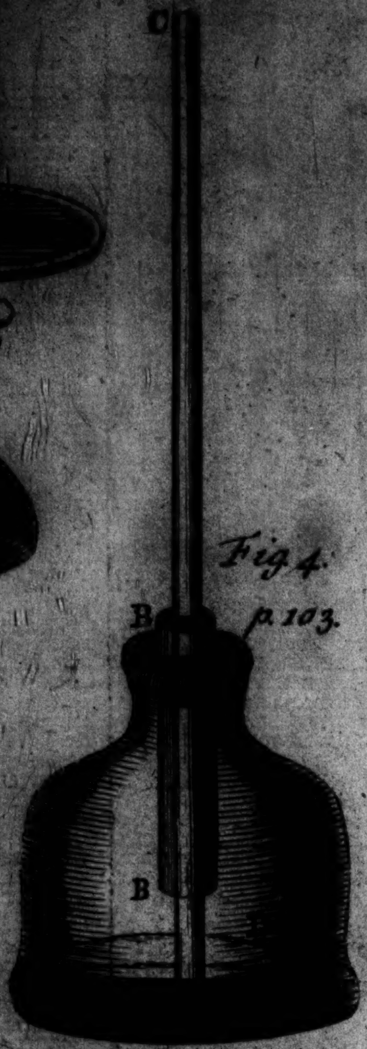
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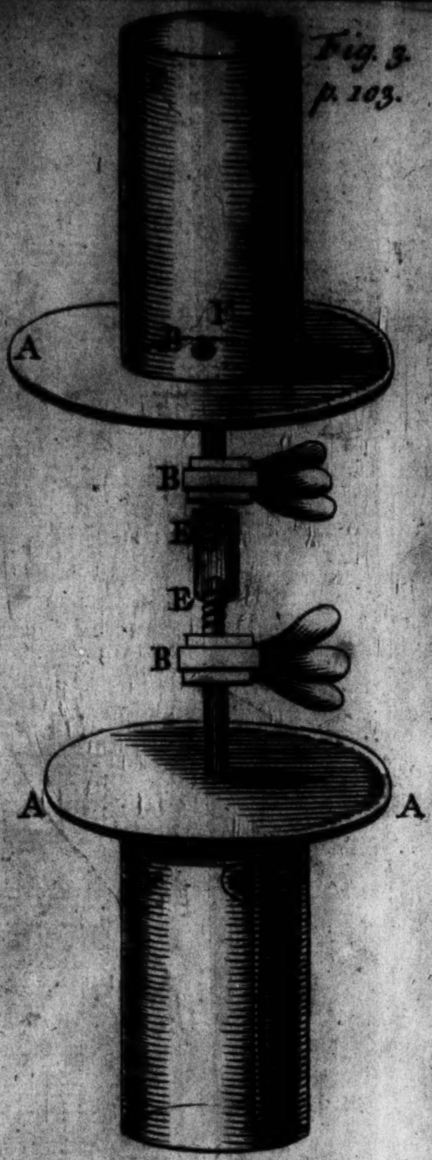
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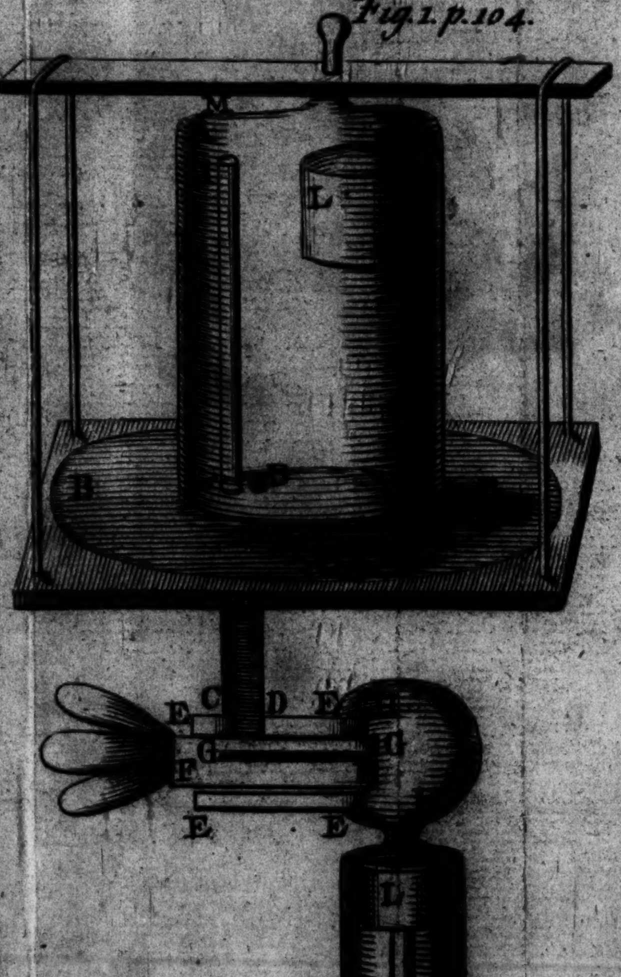
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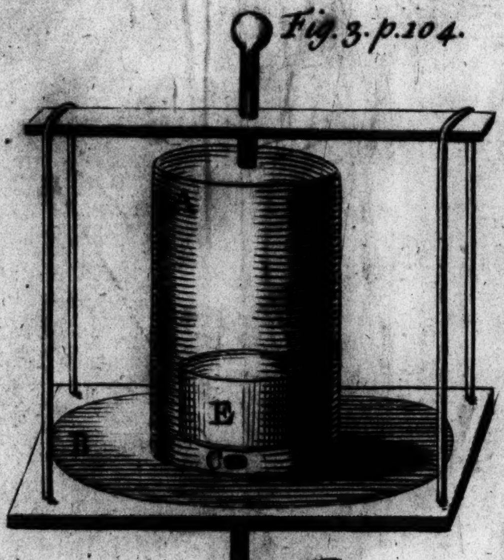
Fig. 3. p. 104.

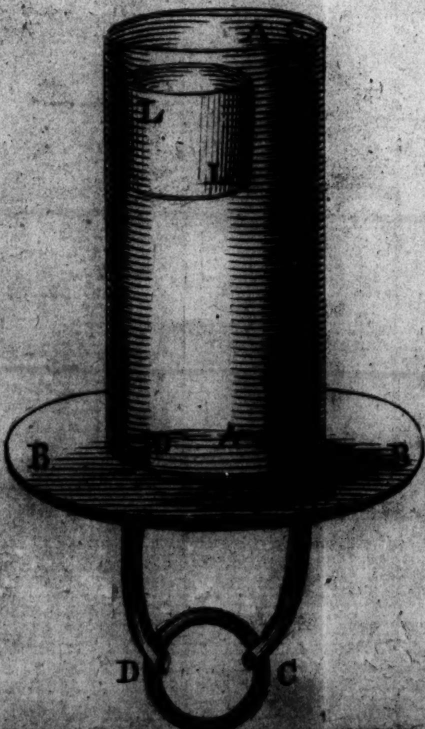
Fig. 2. p. 104.

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Fig. 1. p. 105.

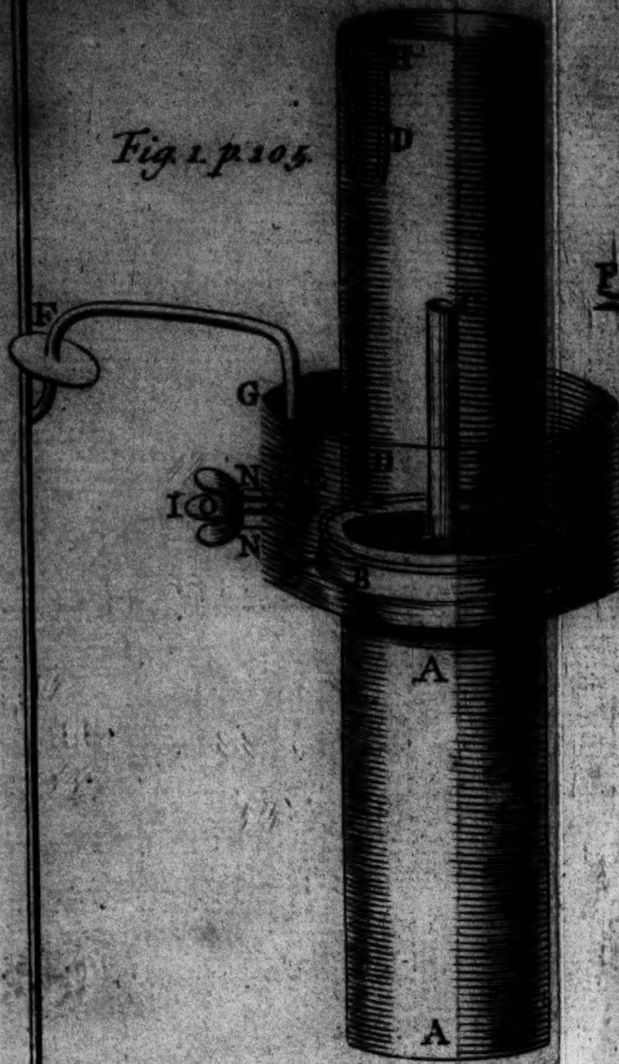
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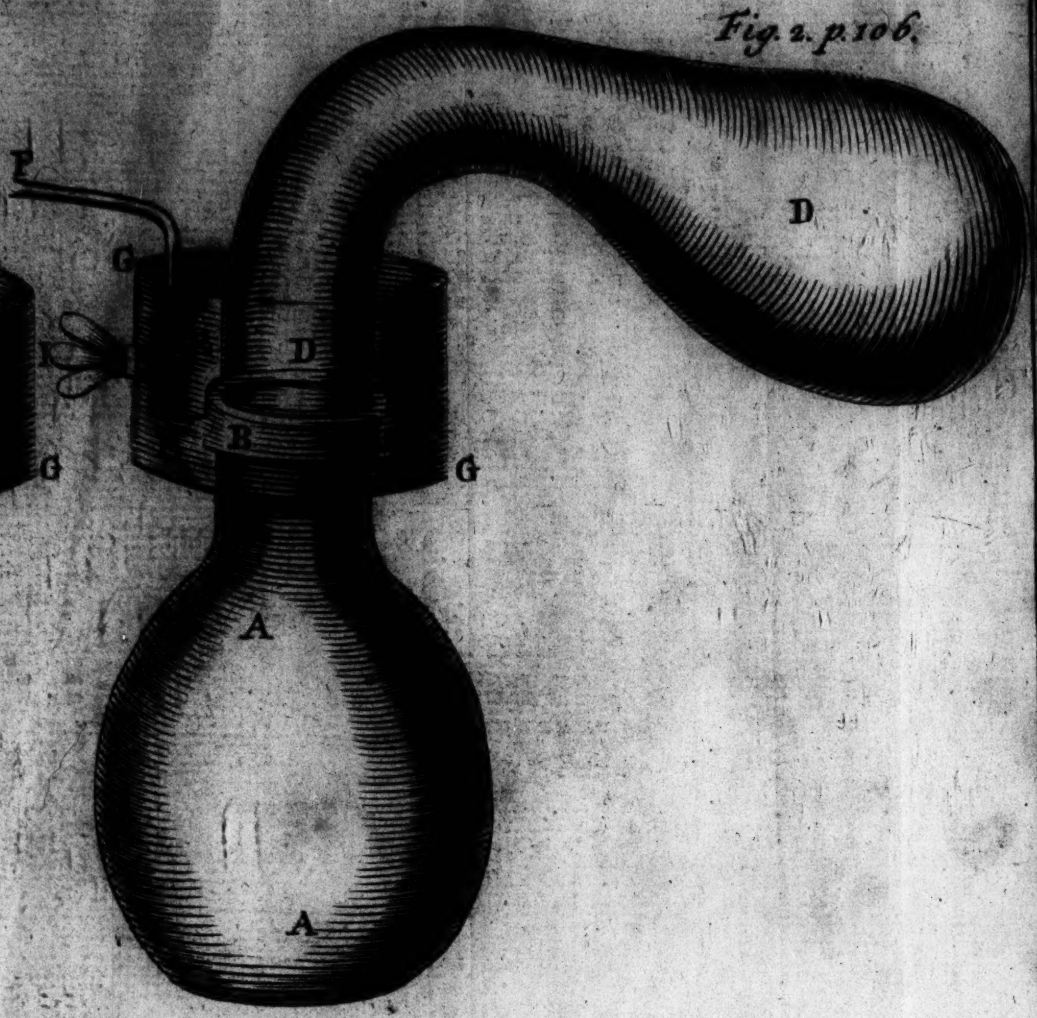
Fig. 2. p. 106.



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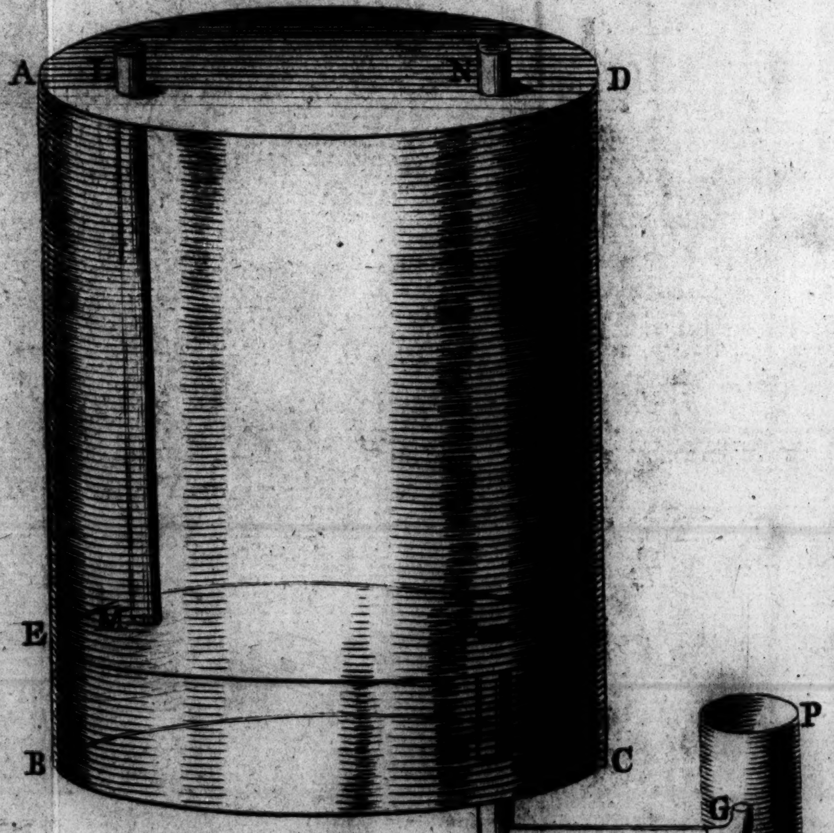
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